SAE Journal

FEBRUARY 1952

PUBLISHED BY THE SOCIETY OF AUTOMOTIVE ENGINEERS

Piston ring progress

1945

The life of tank and aircraft engines early in the North African campaign was measured not in terms of months, weeks, or days . . . desert heat and sand wore out cylinders, pistons and rings in a matter of *hours!* Prolonged efficient operation was a military necessity and it was achieved through the application of solid chrome plate to the piston rings.

1946-50

The experience with chrome under the most severe operating conditions was applied by Perfect Circle engineers to peacetime service in tractors and trucks. Improvements were made in ring design and plating techniques . . . astonishing records were established for economy, piston, cylinder and ring life.

1951

The advantages of solid chrome plated rings were then made available both as original equipment and as replacement parts. The results surpassed all expectations . . . in performance and in acceptance. Throughout the industry, solid chrome plating, as developed by Perfect Circle, is regarded as a milestone in piston ring progress.

TODAY **21 of the 25 automotive engine manufacturers using chrome rings as original equipment specify Perfect Circles.**

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Perfect Circle

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155

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for making 'egg-shaped' holes serve as ROUND ONES... in car engines!

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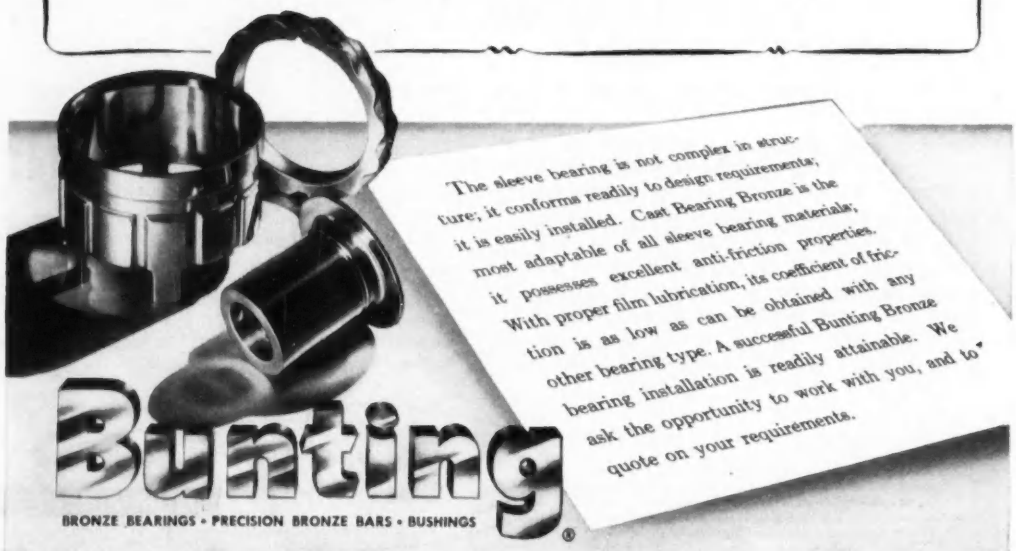
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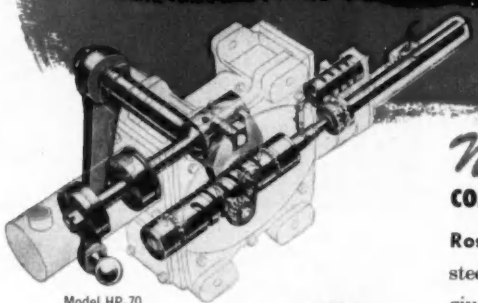

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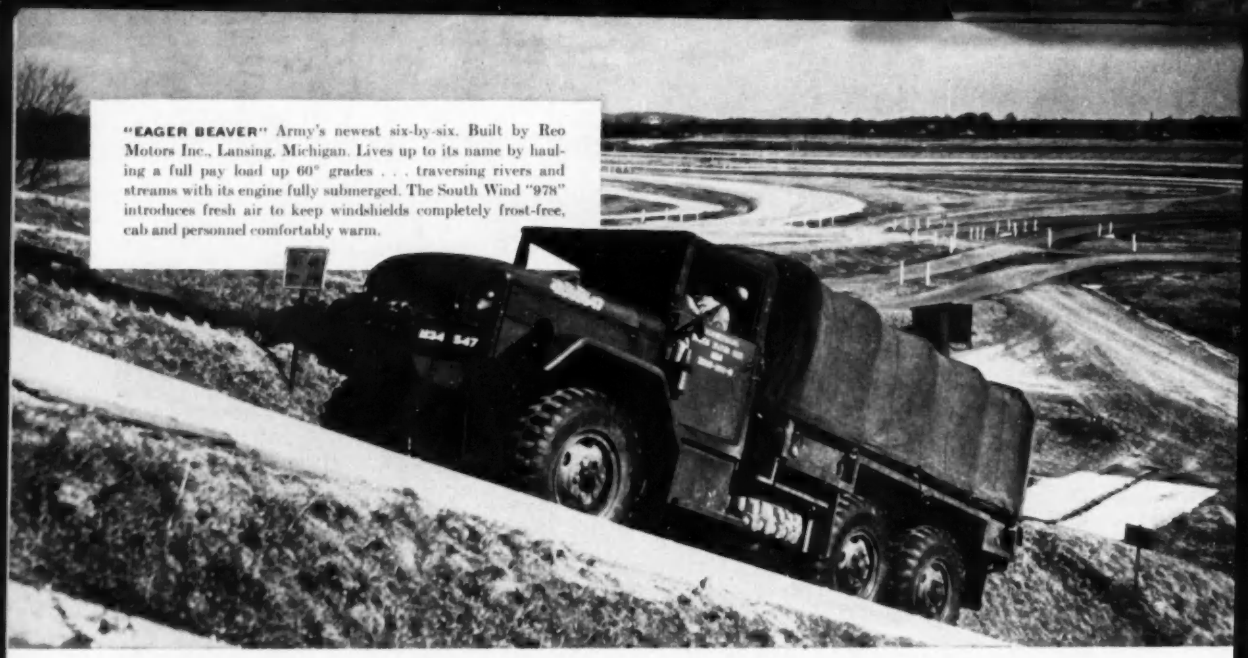

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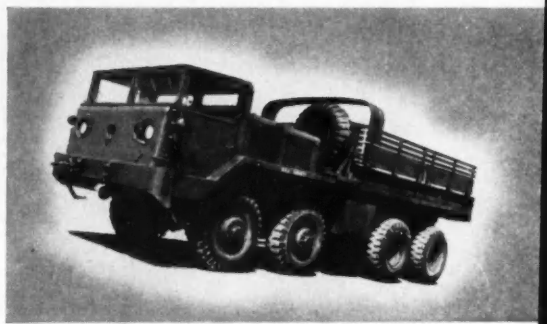

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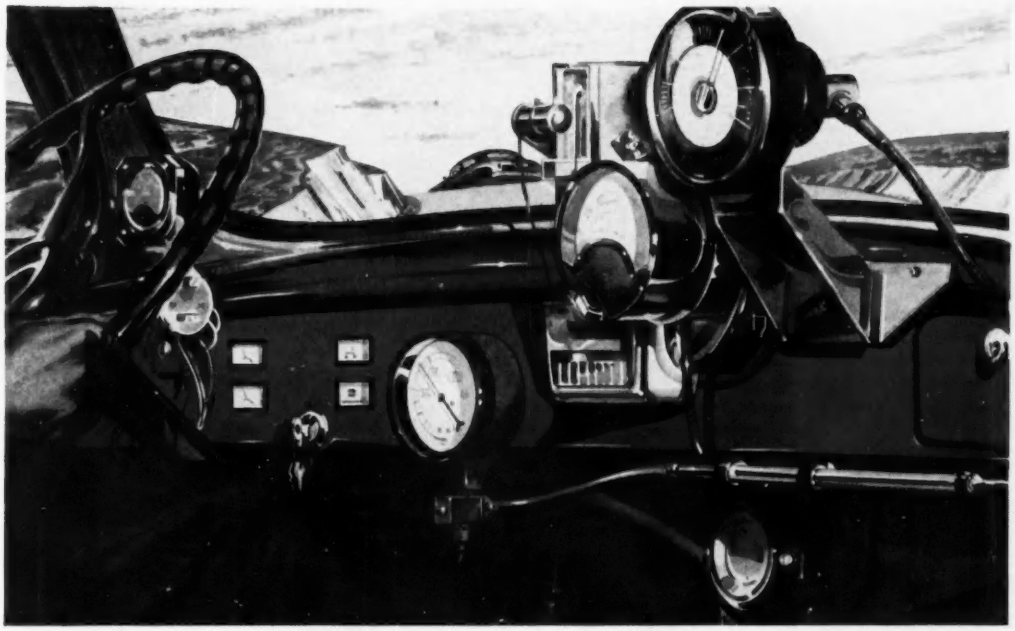

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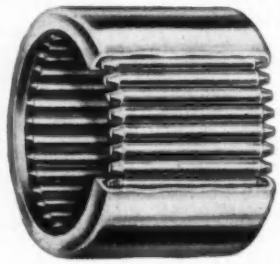

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The elastic modulus increases with strength. In this respect nickel-containing irons of the high strength type possess good stiffness and do not deform permanently under loads that would be damaging to irons of lower elastic modulus.

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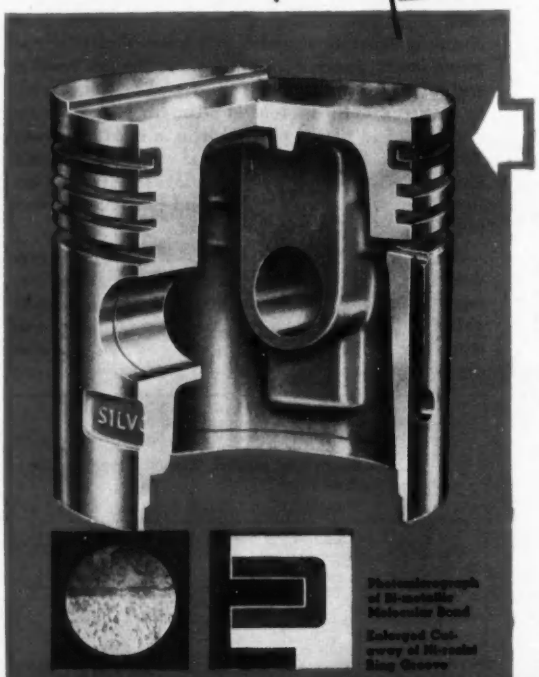

Photomicrograph of Bi-metallic Molecular Bond

Enlarged Cut-away of Nicrosilal Ring Groove

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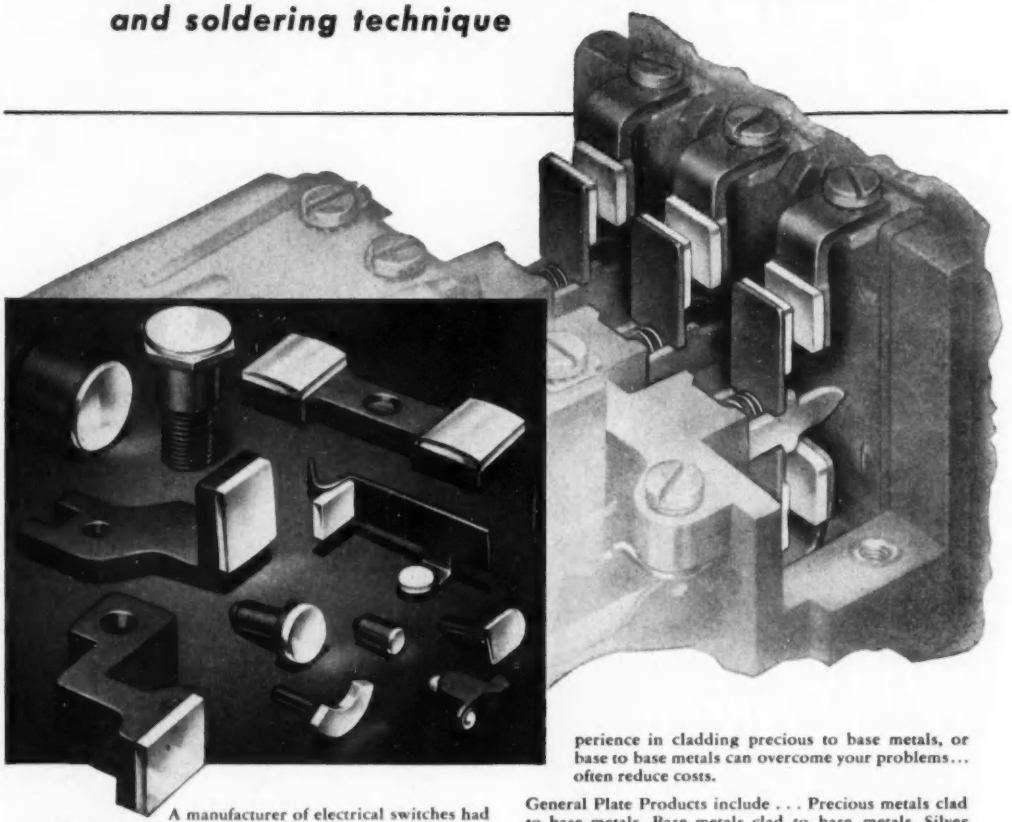

A manufacturer of electrical switches had difficulty in obtaining the required bond area in brazing a silver contact to a base metal part.

The problem was presented to General Plate engineers who provided the solution by developing a special solder and soldering technique. The result was a joint with 85% bond area which provided the necessary strength and electrical and thermal conductivity.

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For the Sake of Argument

The "We" Approach . . .

By Norman G. Shidle

The "we" approach to directing people usually gets better results than the military or "do it" method. At least that's what a supervisor of men and women—noted for getting things done—once told us.

His comments, as we recall them, ran something like this: Starting with "What do you say we try to get this out before the end of the week" opens the way for valuable positive reactions by the receiver of the "order."

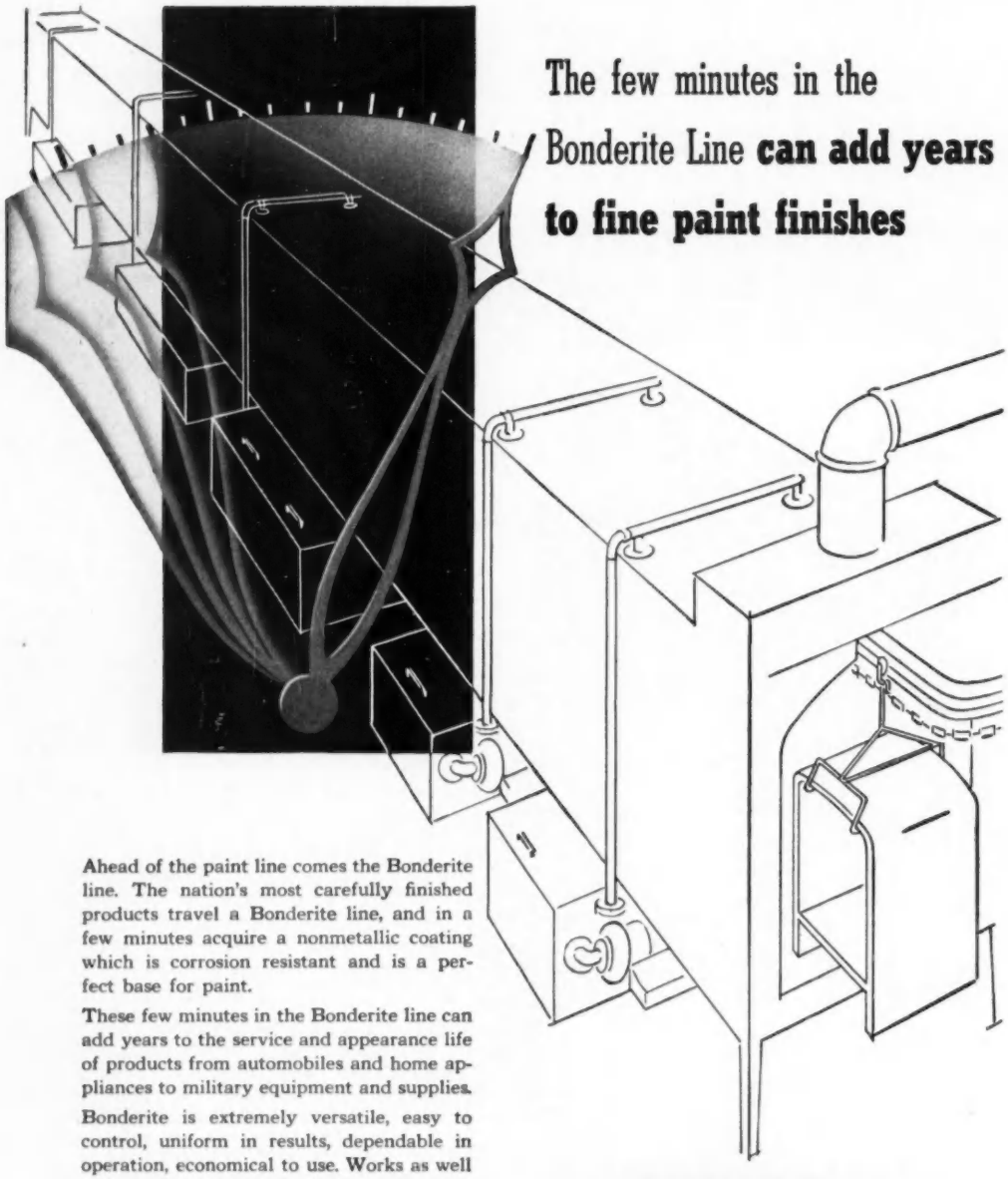
It gives him a chance to act on his own initiative, for one thing . . . and that always means more aggressive, intelligent performance. He can think of himself as an equal participant with the boss, too, which automatically gives the project increased importance in his eyes. It helps him to see the job as really worth doing—because the boss is thinking of it as something worth his own participation.

All these possibilities work toward stimulating the man on the receiving end to fullest use of his talents. And when that happens, projects naturally get finished better and faster.

There's always the problem, of course, of the individual who responds sluggishly, if at all, to the "we" approach. Some people are like that. But, says our counselor, you can't afford to have many such people in your organization for very long. Those who act only under the whip of command, rarely, if ever, do bring their full talents into play, rarely do jobs good and fast. Besides, even the sluggard may do worse when whipped. So the "we" approach is a pretty good personnel-selection tool—when used with wisdom and patience.

The "we" approach has a lot of supplementary benefits, also, both to the user and the receiver. It's likely to provide more harmony, better feelings inside everybody concerned. But its practical merit, our friend insists, is that it gets better business—and engineering—results.

He ended his little homily, however, with this warning: "We all know, of course, that 'Honesty is the best policy, but he that operates on that policy is not an honest man.' So, the 'we' approach is worse than any other when attempted by anybody who does not really feel it and mean it."



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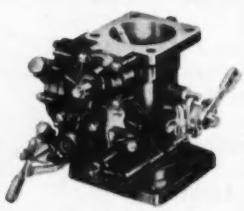

Stromberg Carburetor
PS-5C used on Le Sabre

An experiment in the automotive future—a low sleek sports car with dramatic, sweeping lines of a jet aircraft is how General Motors describes its new car, the Le Sabre.

Every advanced engineering and styling feature was planned with the thought of finding out if the futuristic ideas of today might prove to be the accepted standard of tomorrow's conventional motor car.

For example, although Le Sabre carburetion presents an entirely new problem due to the use of methyl alcohol, together with current premium fuel, the carburetor itself is a specially designed Stromberg®—the quality carburetor on today's conventional motor car.

For any car manufacturer planning for future requirements or meeting today's need for finer, more dependable carburetion—Stromberg is the answer.

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ELMIRA, NEW YORK

1952 Annual Meeting Brings 57 Papers by 89 Authors

1951 SAE President Dale Roeder and 1952 SAE President D. P. Barnard both spoke at the Annual Meeting Dinner

EVERY one of SAE's 12 Professional Activities brought to the 1952 SAE Annual Meeting facts and ideas for the whole Society membership. A minority of the papers contributed solely to the specialized fields in which their authors work. Power steering, engine bearings, iron and steel developments, performance of fuels and lubricants and scores of other topics had broad technical interest. Dramatic news about guided missiles, military vehicle tests, and Munitions Board operations touched common interests in national defense developments.

This 1952 Annual Meeting—held Jan. 14 to Jan. 18 at the Sheraton-Cadillac Hotel in Detroit—had 22 formal technical sessions. In the writing of its 57 technical papers, 89 authors participated. In addition, scores of technical and administrative committee meetings were held during the week.

The Annual Business Session of the Society was held on Tuesday evening, Jan. 15 at 8 p.m.

A high spot of the week, as usual, was the Annual Meeting Dinner where some 4000 members and guests heard Dr. Kenneth McFarland's inspirational talk about men and motives and actions. Dr. McFarland is educational consultant, General Motors Corp. Master of Ceremonies at the big affair was Elmer A. Clark, vice-president of The Budd Co. 1951 SAE President Dale Roeder and 1952 SAE President Dr. D. P. Barnard both spoke at the dinner, where SAE Detroit Section Chairman W. H. Graves opened the speaking program with words of welcome from the Annual Meeting's host Section.

Entertainment feature of the Dinner was a series

Continued on Page 61

Answers at 3 Tractor

Quality Control Panel members were: Secretary John Santi, Marquette University; E. R. Meyer, Eureka Williams Corp.; J. N. Berrettoni, Dr. J. N. Berrettoni & Associates; Panel Leader H. A. Weissbrodt, International Harvester Co.; Carl Slathar, Minneapolis-Moline Co.; E. L. Fay, Deere & Co.; and W. H. Smith, Ford Motor Co.

Quality Control Panel

REPORTED BY

John Santi, Marquette University

Panel leader was H. A. Weissbrodt, International Harvester Co.

Question:
What can be done when a large number of customers specify different quality levels in the same assembly?

Answer:
There is no specific cure for this problem but much can be done by the sales department to to reduce the number of quality levels. It can unite the requirements of the customer with the specifications of the vendor.

Question:
How is scrap and rework recorded in quality control when applied in foundries?

Answer:
When quality control techniques are used, this problem is greatly reduced since corrective measures can be applied during the job.

Question:
What is the best way to sell quality control to management in a particular plant?

Answer:
Correct one of the outstanding problems in the plant. For example, after determining the percentage of scrap and picking the greatest percentage of failures, apply quality control methods to overcome the cause of these failures. Another important selling point is the fact that data can be presented in such a form that supervision and labor can understand it.

Production Panels

Summaries of questions and answers from three panel discussions on production problems are presented on this and following pages. These three panel discussions were among the seven panel discussions sponsored by the SAE Production Activity at the SAE National Tractor Meeting last Sept. 10.

Question:
Must equipment and gages be changed with the introduction of quality control?

Answer:
To properly record dimensions on charts, it is necessary that air-type gages be at the operation involved; for example, "go" and "no-go" gages, either internal or external, would not be sufficient to determine the range of performance. It is suggested that air-type gages be used on internal dimensions, and some development is now in process for rapid checking of O. D. dimensions. At the present these dimensions are often checked with micrometers by the roving inspector who posts the charts.

Question:
What types of control charts and gages are used in a cut and punch department?

Answer:
Two types of charts meet these requirements—the Bar X and Range charts if the parts are inspected dimensionally, and a P chart to plot the percentage of defective parts if "go" and "no-go" gaging is used. Requirements of different jobs determine the calibration of the gages and charts. Some jobs may require micrometer measurements, and charts will be in terms of thousandths of an inch, whereas, 1/16 in. is perfectly suitable for other jobs.

Question:
Does quality control increase inspection?

Answer:
Most companies using quality control find that it usually decreases inspection.

Question:
What quality of men are required as inspectors in a foundry?

Answer:
They should be selected on the basis of their background and potential ability to perform the work of quality control men or inspectors. Then, they should be taught the job by competent men.

Question:
Can any suggestion be offered for a rational determination of acceptable quality level?

Answer:
Sampling tables may be selected for a desired AQL. However, different jobs will require that the AQL take into consideration the minimum and maximum percentage of defectives allowable to fill the requirements of the particular job.

Question:
How should quality control be presented to labor unions?

Answer:
This is an all-important question and is one program where management and labor are on common ground. It is advised that top management meet with top supervision and members of the bargaining committee to explain the fundamentals of the quality control program and its benefits to both groups. Two points in particular should be stressed: (1) conservation of critical material by reduction of scrap; and (2) improvement in the quality of the product, which will result in satisfied customers, repetitive sales, and therefore job security. This program should be carried on constantly (similar to a safety program) with slogans posted periodically at strategic points in the plant to keep the quality control program constantly before the employees. This applies not only to production men but also to office and service departments, such as tool room, machine repair, electricians, and so forth.

Question:
How should inspection be handled in regard to qualification of labor or management?

Answer:
Inspection and quality control should definitely be considered as part of management and should function as such. Inspection consists primarily of making routine checks and measurements of parts, and checking these dimen-

sions against specifications. Quality control techniques, however, utilize the information gathered by these inspections, statistically analyzing them to determine the capabilities of a process, as well as to make predictions of quality on the basis of sample inspecting. In addition, quality control serves as a tool for the inspection department, and as an aid to the production foreman.

Question:
How does the pay of an inspector on quality control compare with the pay of a product inspector?

Answer:
Generally speaking, the pay should be on the same level as when the inspector was formerly on 100% inspection. He is trained to cover the area to which he is assigned and record his findings on the chart. Knowledge required is fundamental and no greater responsibility is involved, therefore the labor grade should be the same as the bench inspector.

Question:
Where does inspection leave off and quality control take over (or vice versa) to avoid overlapping of duties and responsibilities?

Answer:
With quality control methods in a plant, the inspection department functions in the normal manner. But the quality control department sets up sampling and inspection plans, as well as systems of charting and recording, which the inspection department carries out. Very often the quality control department assists the head of the inspection department in setting up standards and policies of inspection. However, the inspection department still retains its responsibility for checking the parts and maintaining records. In many plants both come under the supervision of the chief inspector, not as separate departments.

Question:
How should quality control be applied on a product where the human element is involved, for example, hammerman in a forge shop where dies and equipment are satisfactory?

Answer:
By analyzing the charts and records of the job (utilizing correlation techniques), it is possible to isolate the effect of the man and the machine from the overall variations. Probability curves for more than one operator or a continuous control chart through various shifts will bring out the effect of the individual operator upon the operation.

Question:
How do you trust the men who are taking the data?

Answer:
It is often possible to spot faulty records by spot checking the data and maintaining regular checks on the data. Some plants have utilized quality control men to police the work of those who record the data.

Question:
Should engineering be part of the quality control department.

Answer:
The quality control department functions best as a separate department, though it should have the cooperation of the engineering department.

Question:
Is it practical to set up a quality control inspector with the authority to stop a job which has gone wrong?

Answer:
No, that function is the responsibility of the production foreman, assuming he is of the proper caliber.

Question:
When a lot fails to pass sampling inspection, who should do the detail inspection of said lot —the inspection department or the department that produced the defective work?

Answer:
The production department should do the detailed segregation. However, this work often falls back on the inspection department because of agreements in the union contract.

Question:
What are the advantages of quality control over 100% inspection?

Answer:
One hundred percent inspection normally does not offer any more information about the job than a sampling based upon quality control methods. Consequently, much additional cost and time is consumed with no gain. In addition, quality control methods offer an analysis as to the troubles with the job, whereas 100% inspection merely presents a historical record of it.

Panel members lend a willing ear to comments made by Igor Kamlukin, Allis-Chalmers, at the panel discussion on gears. (Left to right) A. S. Black, Fellows Gear Shaper Co.; J. C. Straub, American Wheelabrator and Equipment Corp.; N. T. Nilson, International Harvester Co.; Fred Bohle, Illinois Tool Works; Panel Leader B. W. Keese, Timken-Detroit Axle Co.; Charles Staub, Michigan Tool Co.; F. H. Boor, Timken-Detroit Axle Co.; Kamlukin; B. G. Rich, John Deere Waterloo Tractor Works; and Secretary Donald Rieff, Harnischfeger Corp.

Gears Panel

REPORTED BY

Donald Rieff, Harnischfeger Corp.

Panel leader was B. W. Keese, Wisconsin Axle Division, Timken-Detroit Axle Co.

Question:
What is the place of multi-thread hobs in production?

Answer:
Output increases but not directly since slower feeds are required. Quality is decreased—to the extent that there is a point of maximum return beyond which it is not advantageous to use multi-thread hobs.

Question:
Can unground hobs be used to advantage in shaft splining or cutting of gears?

Answer:
Manufacturing costs are approximately 15 to 20% lower with unground hobs, but poorer quality jobs generally result. Satisfactory results have been obtained when the lead is not too great. Type of equipment used and method of tool mounting are important.

Question:
When gears are tip relieved is that the same as reducing the O. D. and involute action?

Answer:
Yes, some manufacturers actually increase the gear outside diameters the amount of tip relief to compensate.

Question:
Which is better—keying or splining of gears?

Answer:
With fixed or on-sliding gears it does not make much difference which method is used. Keying is cheaper, but splining gives more contact surface on soft bores. Splining is better on sliding gears because of the greater contact surface and the ability of multiple splines to carry greater loads.

Question:
Why is involute splining becoming popular?

Answer:
Involute splining is becoming popular because of the ease in manufacturing; inaccuracies do not affect the job as much as in straight splining.

Question:
What factors must be considered in selecting the pitch to use with involute splines?

Answer:
Smaller pitch splines weaken the shaft less; the shaft usually fails before the key. Finer pitches allow less initial hub wall thickness. Load carrying capacity, type of material, and depth

of penetration in a carburized member all have a bearing upon the selection.

Question:
Can spur gears be made as quiet in operation as helical gears?
Answer:
No.

Question:
Is the gear noise problem always solved by accurate gears?
Answer:
No, while the entire job must be accurate, each job requires a special approach to overcome noise.

Question:
What are some of the factors which must be considered in selecting the finish for production cut gears?
Answer:
Too fine a finish presents lubrication problems. Gear velocity is also important.

Question:
How do boron steels fit into the gear materials picture?
Answer:
Results are still questionable, but shrinkage is greater than in comparable ordinary steels. Distortion problems are arising, but higher heat and a fast quench are solving some of them.

Question:
What role does shot peening play in determining the life of gear teeth?
Answer:
While static strength is not increased by shot peening, at least 15% increase in life can be expected. The heavier the sections involved, the more shot peening can be used to advantage. Prior to machining, shot peening has little effect. It should be done after hardening.

Heat–Treating Panel

REPORTED BY
Al Mayer, Student, Marquette University

Panel leader was J. T. Schoen, Marquette University

Question:
How will the increasing shortages of alloying materials affect availability of alloy steels?
Answer:
Alloy users will have to resort to carbon steels of high carbon content. Boron steels will also be used for section sizes up to those where shrinkage and distortion become excessive.

Many parts have previously been made from steels of unduly high alloy content. Stress studies of such parts may show that—with little or no redesign—carbon steels will suffice.

Question:
What about marquenching boron steels?
Answer:
Marquenching can be done in either a hot salt bath or a hot oil bath. In heat-treatment, marquenched parts suffer less distortion and decarburization but require longer treatment.

Question:
Why do we get soft spots on the bar stock we harden?

Answers at 3 Tractor Production Panels

Answer:

The soft areas have been decarburized. This might be avoided by hardening by induction heating. Some say you can't reheat an induction-hardened piece, but at least one company does it successfully.

Question:

Would it be wise to flame-harden SAE 1045 shafts of 2-in. diameter?

Answer:

Flame hardening is usually applied to large gears. It is not recommended for smaller objects—induction hardening is better.

Question:

We are thinking about installing our own heat-treating department to treat about fifty SAE 4320 gears a day. The pieces are about 9 in. in diameter and weigh 10 lb. What kind of equipment should we buy?

Answer:

Salt-bath heat-treat equipment is best for this type of small-production shop. Gas equipment could be used but is preferable only for shops where loads are over 200 lb per hr.

Question:

What materials can be substituted in furnace equipment for the now-hard-to-get nickel alloys?

Answer:

Carbon steel is working fairly well for skid rails and radiant tubes. However, the carbon-steel tubes are short-lived.

Certain other parts are being made of ceramics.

Question:

What are the comparative advantages of cyaniding and nitriding?

Answer:

Cyaniding is better for light case work, but cyanide is expensive and increasingly scarce.

Nitriding is cleaner and safer to use. It incurs a little distortion, but the distortion is easy to correct. Case depths as shallow as 0.015-0.030 in. are possible on very small parts processed in a rotating table system.

Question:

How is the machinability of the 14BXX series?

Answer:

Machinability is not very good. The higher the carbon, the poorer the machinability.

Question:

Do you or don't you need core hardness in a carburized gear?

Answer:

The experts differ on this one, but don't forget that as core hardness increases, case depth decreases.

Question:

What plain carbon grades would you suggest for axle shafts?

Answer:

SAE 1045 and SAE 1055 are good plain carbon steel grades to try. The shafts should be normalized, then machined, and finally induction hardened.

Heat-Treating Panel

L. W. Steege, John Deere Waterloo Tractor Works; L. E. Webb, Clark Equipment Co.; Panel Leader J. E. Schoen, Marquette University; J. H. Clark, International Harvester Co.; E. E. Alexander, Caterpillar Tractor Co.; C. I. Wesley, Wesley Heat Treating Co.; and Walter Holcroft, Holcroft & Co., were the members of this panel. Secretary was Al Mayer, Marquette University

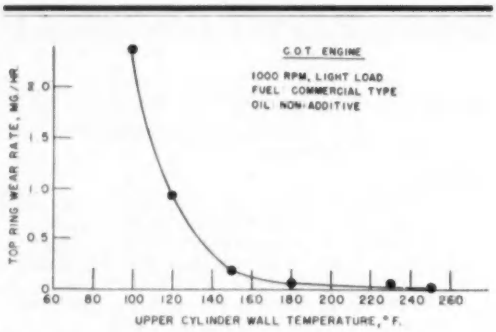


Fig. 1—Engine wear increases rapidly with decreasing cylinder wall temperature in the 100 to 150 F range

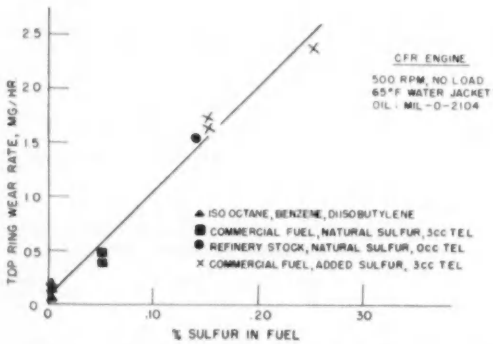


Fig. 2—Low temperature engine wear increases in essentially a straight line relationship with increasing sulfur content in fuel

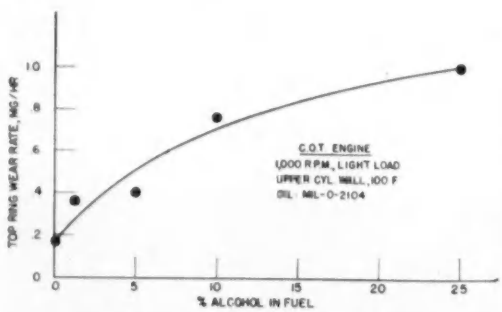


Fig. 3—As little as 1 to 2% alcohol in alcohol-gasoline blends has a definite effect on low temperature wear

Rate

TYPES of fuels and lubricants used in internal combustion engines play a major role in determining the wear which takes place at low engine operating temperatures. Recent radioactive tracer tests on two single cylinder laboratory engines indicate that:

- Low temperature wear increases in essentially a straight line relationship with increasing sulfur content in fuel in the range of 0 to 0.25% sulfur.
- As little as 1 to 2% alcohol in alcohol-gasoline blends results in a definite increase in low temperature wear.
- Use of a properly compounded lubricant reduces wear at low operating temperatures.

Wear Greatest at Low Jacket Temperatures

Studies were made of engine wear at low water jacket temperatures since wear is most serious under that condition. To illustrate this point, a C.O.T. (Cooperative Oil Test) engine was operated at moderate speed and light load over a range of cylinder wall temperatures from 100 to 250 F. The data, see Fig. 1, show that wear was small and essentially linear between 160 and 250 F, but that it increased rapidly with decreasing temperature in the 100 to 150 F range.

Sulfur Content Important

A series of low temperature tests run on a CFR engine demonstrated the importance of sulfur content in fuel. Tests were carried out with a variety of fuel types, with varying amounts of tetraethyl lead, and with both naturally occurring and added sulfur. Wear was found to increase in essentially a straight line relationship with increasing sulfur content in the range from 0 to 0.25% sulfur. (See Fig. 2.) Results showed that the quantity of sulfur in fuel is by far the most important fuel variable from the wear standpoint—fuel type, sulfur source and tel content have a negligible effect.

Effect of Alcohol-Gasoline Blends Studied

The effect of alcohol in alcohol-gasoline blends on low temperature wear was also studied. Data obtained on C.O.T. engine tests attested to the adverse effect of this fuel variable. (See Fig. 3.) As little as 1 to 2% alcohol showed a definite increase in wear.

Acidity of the exhaust gas increased with in-

# of Engine Wear Depends on Fuels & Lubes

BASED ON PAPER BY

H. R. Jackson, F. C. Burk, L. J. Test, and A. T. Cowell

The Atlantic Refining Co.

• Paper, "Some Phenomena of Engine Wear as Revealed by the Radioactive Tracer Technique," was presented at the 1951 SAE National Fuels & Lubricants Meeting, Chicago, on Nov. 1, 1951. (This paper will appear in full in SAE Quarterly Transactions.)

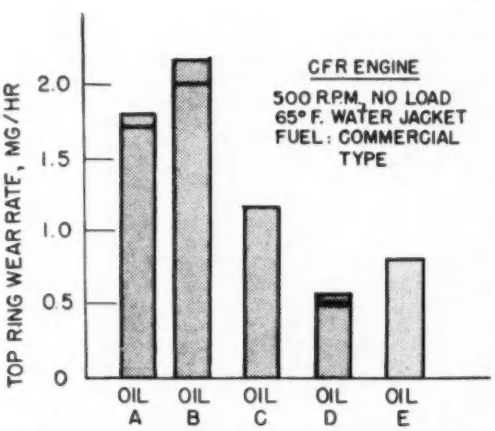


Fig. 4—Wide differences in low temperature wear rates occur with various non-additive type lubricating oils

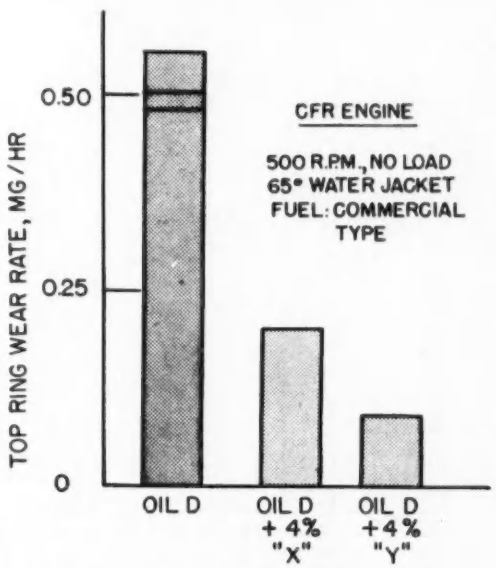


Fig. 5—Certain types of oil additives have the ability to reduce low temperature wear

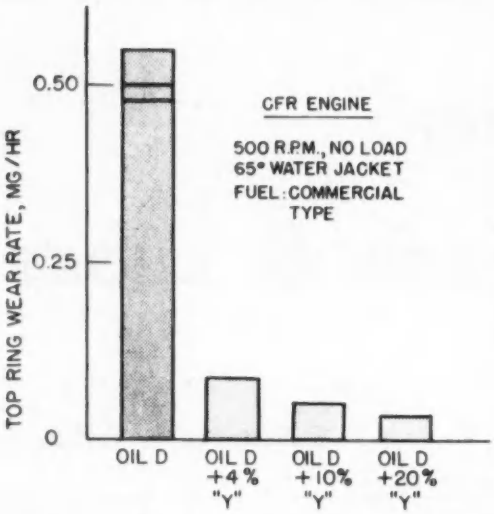


Fig. 6—Higher and higher additive concentration results in lower and lower wear, but a saturation effect exists

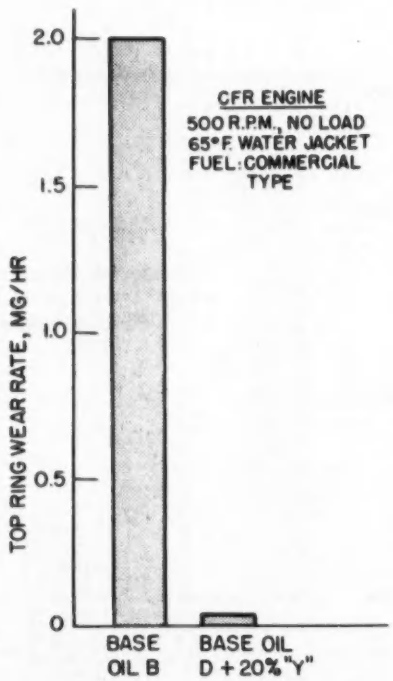


Fig. 7—Proper selection of base stock and additive type and concentration reduced low temperature wear by a factor of approximately 70 to 1, taking into consideration the two extremes encountered in the test work

creasing amounts of alcohol. It would thus appear that alcohol during combustion forms more corrosive products than does gasoline.

Proper Selection of Lubricating Oil Can Help

The desirability of using an additive type lubricating oil was established by several investigations.

CFR engine tests showed the wear differences which occur with various non-additive lubricating oils under low jacket temperature conditions. (See Fig. 4.) Oils from different crude sources and treated by different refinery processes were included. They were all of SAE 20 classification, and represent typical stocks used in motor oil blends.

It has not been possible to relate the wear differences found to any physical property of the oils. But it appears that differences in refining procedures and crude source combine to effect low temperature wear rates. It is thus important—when designing a finished motor oil blend—to begin with a base stock that permits a minimum of wear.

Other tests on the CFR engine, however, brought out the fact that certain types of oil additives have the ability to reduce low temperature wear. (See Fig. 5.) Two chemically similar alkaline metallic-organic detergent additives, X and Y, were tested, and one was found to be approximately twice as effective in reducing wear as the other.

The effect of various percentages of additive Y in base oil D is shown in Fig. 6.

Higher and higher additive concentration resulted in lower and lower wear. There is a saturation effect, however, in that the first several percent of the additive effected the largest proportional drop in wear.

Taking into consideration the two extremes encountered in the test work, proper selection of base stock and additive type and concentration reduced low temperature wear by a factor of approximately 70 to 1. (See Fig. 7.) Thus the deleterious effect of low temperatures on wear can be reduced by the use of a properly compounded lubricant. This is shown in Fig. 8 which gives the wear comparison between a base and additive oil on the same chart.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

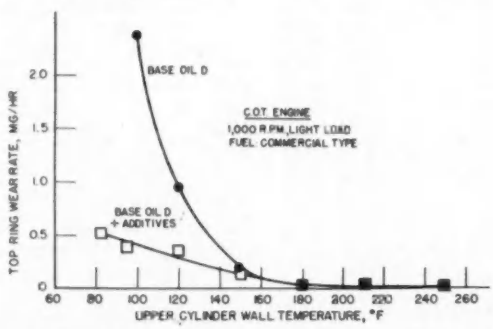


Fig. 8—Use of a properly compounded lubricant reduces engine wear at low temperatures

Based on Discussion

IN the ensuing discussion, other researchers (1) noted which variables carry the greatest weight when all are present; (2) pointed out that conclusions drawn from low temperature engine wear research data are not always valid; and (3) stressed possible ways to reduce low temperature wear.

Sulfur Content Dominant Factor

Caterpillar's R. E. Kennemer reported that increasing diesel fuel sulfur content increased ring and cylinder wear not only at low temperatures but also at normal cylinder temperatures. And, he added, data from a recent series of tests on a single cylinder diesel engine show that—even with a high additive lubricating oil and normal operating conditions—top ring, oil ring, and cylinder wear are each roughly proportional to the fuel sulfur content.

Furthermore, Richard Wiebe of the U. S. Department of Agriculture pointed out, present experiments with low (0.13%) and medium (0.24%) sulfur gasolines—with 50 : 50 alcohol-water mixture injected for 3 min at full-throttle—indicate no significantly different results with or without injection. This, Wiebe explained, was probably because the sulfur effect over-shadowed the other possible contributions.

Other Northern Regional Research Laboratory tests, it was brought out, showed that there was slightly less wear from straight-run unleaded fuels to which 25% alcohol was added than when the same fuels were used without alcohol. In either case, however, wear was slight.

Lab Results Not Always Valid

Laboratory low temperature engine wear tests are viewed with some doubt and skepticism, D. S. McArthur of Esso Laboratories observed. Almost two years ago a field test was initiated in a fleet of light delivery trucks in northern New Jersey. This fleet operated in low temperature, stop-and-go type delivery service. The engines in this fleet were a popular, low-priced make. Fuel was a premium quality leaded gasoline. Three different lubricants were used of which oils B and C gave only one-half as much wear as oil A in low temperature (70 F jacket temperature) laboratory tests. (See Table 1.) The trucks were parked outside all night during the winter months to insure good low temperature conditions.

It was found that oils B and C, which had given such low wear in the low temperature laboratory tests, did not show up to advantage in the field. After 10,000 miles of operation, covering a complete winter, oil B and C actually gave somewhat more wear than oil A. (See Table 2.) The fleet will soon have reached 20,000 miles, and so far oils B and C are still giving no lower wear than oil A. It is of interest also that the rate of wear in the delivery trucks is considerably lower than the rate of wear in the laboratory engines. For example, the field engines are wearing at only one-quarter the rate of the laboratory test engines.

These results suggest that there is more to be learned about wear in the field than can, at this time, be safely predicted from laboratory tests. Additional work on the mechanism of engine wear in the field, the effect of engine metallurgy on wear, and the development of realistic laboratory engine tests to study wear is badly needed.

Short Warm-Up Cooling System Needed

C. C. Moore of Union Oil Co. of Calif. expressed the opinion that automotive engine designers would do well to devote some thought to developing a short warm-up cooling system.

He noted that in one popular car recently studied, it required from 10 to 15 min of normal Joe Doakes driving (in an ambient temperature of 60 F) for the jacket water to reach 150 F, and about 50 min before the crankcase oil temperature reached this point. For many motorists, Moore continued, 20 min to a half hour represents normal driving time. This means that unnecessarily high wear rates occur for half or more of their driving.

Any short warm-up cooling system developed to help solve this problem should also be adequate for continuous hot weather and heavy-duty service, Moore concluded.

Table 1—Low temperature wear in a Lauson engine with three different SAE 10 grade oils.

Lubricant	Top Ring Wear Rate mg/hr
Oil A	4.2
Oil B	1.9
Oil C	2.0

Table 2—Field and Laboratory Wear Rates Differ Sharply

Lubricant	Top Ring Wear Rates mg/hr	
	Lauson Engine	Delivery Trucks at 10,000 Miles
Oil A	4.2	0.30
Oil B	1.9	0.58
Oil C	2.0	0.53

Ceramics, Welding, Bonding Are

THE Processing Panel discussed ceramic coating, welding, and metal bonding. It was revealed that three of the major aircraft engine builders in this country already are deeply interested in the ceramic coating of jet engine combustion-chamber liners, nozzle boxes, and other units which must perform under extremely high temperature conditions. British manufacturers also are exploring this field. All engine designers and manufacturers soon will have to fall in line due to the increasing scarcity of the high-alloy material constituents such as cobalt, chrome, nickel and tungsten.

Questions brought out that there are a number of coatings, each with its particular application, and at this early stage in the development of ceramic coatings for high-temperature use, each new job must be studied to determine just which of the coatings will best meet the requirements. To be most effective, the NBS A-418 coating should be applied in a thickness of not less than 0.0005 and not more than 0.001 in., according to one panel member. The application can be made either by dipping or spraying, with the latter preferred. Following application, the coating is fired at approximately 1850 F for parts which must stand up under extreme temperatures.

Ceramic coatings are used primarily to reduce corrosion and oxidation of the base metal. They can also be very effective in increasing radiation, improving gas flow, and resisting gall. The function of reducing corrosion and oxidation is carried out by a first coat; a second coat develops a choice of the other functions.

It was pointed out that the correct ceramic application will increase the working life of high temperature alloys. Also coatings may make possible the use of lower alloys where the high-temperature metals are now used. This will aid materially in reducing requirements for strategic materials in the high-temperature fields.

While ceramics study along the lines indicated is still only on the first few rungs of the ladder, already alloy steels aided and abetted by ceramic coatings have logged service lives of more than 2000 hr in exhaust manifolds for reciprocating engines—such a life comparing favorably with that developed through use of higher alloys.

Answering the question "Can ceramic-coated SAE 1010 steel withstand use at 1200 to 1400 F" the panel advised that if the base metal would stand up under the ceramic firing temperature, it was very likely that the finished product would be highly successful in withstanding these working temperatures.

In answer to another question, the panel indicated that ceramics could be used as a bond between two metals, providing the application called for no greater shear strength than that of the glass binder.

Thorough cleaning of the workpiece prior to the application of a ceramic coating was stressed. Sandblasting was the preferred cleaning method, although in some instances acid pickle also is acceptable. Repair of spall areas usually can be carried out in the field without stripping the workpiece, it was indicated.

When asked what advantages ceramic coatings had to offer other than those available through aluminizing, panel members pointed out that an aluminum coating on sheet metal is not metallurgically stable, nor does it seem to provide the full protection of a ceramic coat.

Summing up the apparent future of this industry, the spokesman indicated that the use of ceramic coatings should be considered as part of the original design and not be added later as an afterthought. It was stressed that the project engineer and the design engineer should be educated in the manifold possibilities offered by ceramics and in their limitations and requirements.

As an offshoot of the ceramic-coating discussion, some time was devoted to metal-ceramic combinations as offering probable relief from use of strategic materials. Notable among the combinations discussed were cemented titanium carbide compositions exhibiting unusually high physical properties at temperatures up to 2400 F. It was stated that chromium and alumina mixtures had proven satisfactory for rocket nozzles and vanes. These materials are powdered, mixed, and either sintered or hot-press formed. For similar applications, iron and cobalt also have been mixed with the alumina. Powder metallurgy offers the theory that solid solutions or spinels are formed during the firing process, which is carried out at temperatures of 2900 to 3400 F.

Here again it was pointed out that the use of cermets should be provided for in the original design, rather than design for conventional application, then attempt to force a cermet construction into the limitations provided. An example offered

Topics of Processing Panel

REPORTED BY

H. W. Ingalls, Patent Assistant, Solar Aircraft Co.

• Panel discussion on Processing was held at SAE National Aeronautic Meeting, Los Angeles, Oct. 3, 1951, under the auspices of the SAE Production Activity. Panel leader was J. V. Long, director of research, Solar Aircraft Co.; panel co-leader was C. L. Hibert, chief process engineer, Consolidated Vultee Aircraft Corp.

was that of the "Christmas tree" construction provided in conventional design for attaching the turbine blade to the wheel. Cermet spokesmen were unanimous in insisting that other joining methods, such as high-temperature brazing and tamping, are preferable and should be considered by the designers.

Discussion of possibilities offered by cermets to get away from the use of scarce tungsten for cutting tools brought out the fact that metal-bonded combinations of titanium carbide, molybdenum carbide and vanadium carbide already have entered the field and are proving fairly satisfactory alternates. It was pointed out that such carbides can be joined to the bit by silver solder, copper braze, and Nicrobraz.

For high-temperature-strength bodies, it was pointed out, a zirconium boride has been developed with melting point over 5500 F. This material, under extreme heats, forms a protective coating of zirconium oxide.

In answering questions regarding the major welding problems in production in today's war economy, panel members reported that the greatest problems are those of procurement and personnel. One company reported that in spite of high priorities, there simply is not enough welding rod to go around. Various customers' specifications make it impossible to use a large measure of the rod which is available. Quoted delivery dates on rod are as much as nine months to a year in the future, while quoted delivery of welding equipment, such as spot-welding machines, generators, and electronic controls currently is running four to six months.

Speaking of the personnel problem, it was stated, "As far back as mid-1950, we anticipated a shortage of qualified welders and immediately opened a welding school. This has been operated continuously since that time. We have trained over 360 welder operators. Of course, we are not able to hold all of these people since the structural industries are offering higher wages on the one hand, and many

Continued on Page 38

Listening to a comment from the audience are Processing Panel members (left to right) W. G. Hubbell, assistant chief, development laboratories, Ryan Aeronautical Co.; G. D. Cremer, staff engineer, Solar Aircraft Co.; Panel Secretary H. W. Ingalls, patent assistant, Solar Aircraft Co.; Panel Leader J. V. Long, director of research, Solar Aircraft Co.; Panel Co-Leader C. L. Hibert, chief process engineer, Consolidated Vultee Aircraft Corp.; L. E. Frost, tool engineer, North American Aviation, Inc.; and F. G. Harkins, welding engineer, Solar Aircraft Co.

PART I of this article appeared in the January, 1952 issue of the SAE Journal. It covered a description of the various turbine wheel failures that occurred during the field testing and what was done to eliminate—or at least reduce the number of—these failures.

Gas Turbine

THE Kenworth truck powered with the experimental 175-hp Boeing gas turbine has now been road tested for over a year. During this time a number of operational characteristics and some important mechanical weaknesses have been brought to light that were not apparent from test laboratory running. As a result, the development of the engine has been greatly accelerated.

Some of the operational characteristics that the testing of this truck has brought out are:

1. Virtually vibrationless riding qualities.
2. Good response to the accelerator pedal.
3. Easier shifting than with a conventional truck engine.
4. Road performance equal to that of a 200-hp diesel engine.
5. Noise level less than that of a conventional truck engine.
6. Ventilation from forward motion adequate without the need for a fan.
7. Fuel consumption higher than expected.
8. Negligible oil consumption.
9. Fewer cold-weather problems.

Road Test Results

The daily logs that were kept during the road testing have been boiled down and presented in Tables 1 and 2. Table 1 gives operating conditions, mileage, and fuel consumption data. Table 2 gives an analysis of the troubles encountered. When the earlier test periods are compared with the more recent ones, a rapid, progressive improvement in increased road miles covered with fewer troubles is evident.

The accumulated road mileage is now over 15,000 and the truck operation time on the original engine, which is still in use, is 550 hr. Most of this mileage and engine time (about 85%) was with trailer attached and loaded with 42,000 lb of old kirksite dies as payload. With the 16,000-lb tractor and 10,000-lb trailer, this brought the gross weight up to the legal limit of 68,000 lb.

Vibrationless Riding

From the driver's point of view there is no question that turbine power for a large truck is very satisfactory. His working conditions are considerably less fatiguing and he is better able to stay alert to the exigencies of highway traffic. Gone are the throb and shake of the piston and connecting rod, the staccato exhaust of the 2- and 4-stroke cycle explosions.

Accelerator Response

Response to the accelerator pedal is good. Surprisingly enough, the turbine needs no apologies in this respect. Recent laboratory tests indicate, in fact, that eventually the turbine will provide a faster response and greater flexibility than can be attained with any existing piston engine.

Gear Shifting

The straight-line, rising torque curve with falling speed of the turbine engine means that:

1. The critical elements of gear shifting on grades with heavy loads have been eliminated.
2. Conservatively, the number of gear steps can be cut in half.

With this engine it is not possible to stall either the engine or the vehicle by improper shifting. To obtain peak engine power and maximum road speed up grades, gear shifts are required, however, to keep the output turbine speed somewhere near the high-efficiency portion of the rpm versus hp curve, as shown in Fig. 1.

Road Performance

Road performance with the combination of 175-hp turbine and 7-speed manually operated hydraulic shift transmission was approximately the same as that of a conventional diesel engine of 200-hp rating and 4-speed gearbox with 3-speed auxiliary (giving 12 gear steps). This is even more impressive in view of the discovery that the turbine, as installed, was losing 10-15 hp because of exhaust gas back pressure in the 90-deg exhaust duct elbows required to clear the chassis frame. In other words, a turbine of 160 hp has been, generally speaking, duplicating the job of a 200-hp diesel engine.

The reasons for this are: (1) The delivered shaft horsepower of the diesel as installed is substantially less than the rating because of the power required for the radiator cooling fan and water pumps, which are not required on the turbine truck. There are

Truck-Part II

General Test Results

BASED ON PAPER BY

Henry C. Hill, Boeing Airplane Co.

• Paper, "Progress of Gas Turbine Truck Tests," was presented at the SAE National Transportation Meeting, Chicago, Oct. 29, 1951.

Table 1—Summary of Road Testing

TEST PERIOD	DATE AND ELAPSED TIME	DESCRIPTION OF TESTS	TRUCK AND ENGINE CONFIGURATION	OIL CONSUMPTION	FUEL CONSUMPTION (DIESEL OIL)	HOURS ON ENGINE IN TRUCK	ROAD MILES	REMARKS
1.	March 15 to May 10, 1950 (2 months)	First road trials, shakedown runs, installation checks, and demonstrations.	Tractor only. Tractor loaded to 30,000 lbs. with ingots. 3-speed auxiliary transmission only. 502-1 engine.	Erratic on account of oil leaks.		58 1/2	855	Preliminary highway runs up to 60 MPH.
2.	May 15 to July 28, 1950 (2 1/2 months)	Transmission tests and adjustments. Investigation of torsional windup in drive line during gear shifts. Noise-level and sound-proofing tests. Cooling tests. Power braking tests.	Tractor only. 32,000 lbs. gross. Carcomatic 7-speed transmission installed. Air inlet baffles and under-hood sound proofing checked out.			140	2,346	Includes first trips in summit of Snoqualmie Pass (3,004 ft.) 95 mi. round trip. Also descents on engine braking without using wheel brakes. (5.6% grade)
3.	Aug. 4 to Oct. 20, 1950 (2 1/2 months)	Oil cooler checks during hill climbs. Noise-level and starting tests. Burner blow out investigation.	40-foot trailer added. Load adjusted to 68,000 gross. Under-hood sound proofing removed. Exhaust mufflers installed. Engine converted to new-type 2nd-stage assembly-cast frame and crossfire tube. Reversing transmission ratio changed from 1:1 to 1.5:1	6-18 to 10-3-50 2 qts., 623 mi. 312 mi./qt. 10-3 to 10-12-50 1 qt., 920 mi. 920 mi./qt.	Two full-load checks made at .87 and .91 mi. per gal.	219 1/2	4,127	Adequate oil cooling with 2 coolers in series in scavenge line - no blower required. Starting reliability greatly improved by crossfire tube. Power on hills greatly improved by changed ratio in reverse transmission.
4.	Oct. 23, 1950 to Jan. 26, 1951 (3 months)	Acceleration and temperature overshoot road tests. Misc. road testing to obtain data affecting combustion temp. and blade failures.	Complete engine inspection and overhaul followed by test-stand investigation of acceleration temp. overshoot. Installed in truck with revised governor control and special thermocouples. Carcomatic transmission, 40-foot trailer, 68,000 lbs. gross. Cab heater connected to engine oil system.			239 1/3	4,910	Cold weather starting and operating experience obtained at temps. down to 10°F. Operation in snow with chains on Snoqualmie Pass. Clutch flywheel burst due to slipping and overspeed. Temperature overshoot now OK. Acceleration still satisfactory.
5.	Feb. 10 to Aug. 20, 1951 (6 1/4 months)	Extended road endurance. Further engineering tests deferred in order to build up road miles and engine time with full load. Fuel consumption checks on level and mountain roads.	Clutch and flywheel removed. 35-foot trailer obtained to replace 40-foot trailer for out-of-state trips. Adjustments in Carcomatic transmission to improve smoothness of shifts. 2nd engine prepared as spare.	2-12 to 3-9-51 4 qts., 1502 mi. 376 mi./qt. 3-29 to 4-16-51 1.5 qts., 1810 mi. 1200 mi./qt. 5-31 to 6-8-51 1.5 qts., 856 mi. 570 mi./qt. 6-14 to 6-25-51 1/2 qt., 1192 mi. 2380 mi./qt. 7-12 to 7-19-51 1 qt. 1044 mi. 1044 mi./qt.	1.00 to 1.19 miles per gal. at average speeds of 21.4 to 30.8 MPH (full-load).	575	14,880	1,095 mi. during Feb. 876 mi. during week of April 9-13 (5 seven-hour days). 842 mi. during week of May 14-19. Routes included trips to: Tenino 137 mi. Cle Elum 182 Castle Rock 232 Stevens Pass Summit 195 Easton 163 Centralia 169 Mary's Corner 191 Bellingham 151 Aberdeen Jct. 187 Toledo 202

Table 2—Summary of Troubles Encountered during Road Testing

	FIRST PERIOD SHAKEDOWN TESTS		SECOND PERIOD TRANSMISSION, COOLING, NOISE, AND POWER BRAKING TESTS		THIRD PERIOD FULL-LOAD TESTS WITH TRAILER		FOURTH PERIOD ACCELERATION AND TEMP. OVERSHOOT TESTS		FIFTH PERIOD ROAD ENDURANCE WITH FULL LOAD			
									FIRST HALF		SECOND HALF	
	Mar. 15 to May 10, 1950		May 15 to July 28, 1950		Aug. 4 to Oct. 20, 1950		Oct. 23, 1950 to Jan. 26, 1951		Feb. 10 to June 8, 1951		June 11 to Aug. 20, 1951	
	Months 2 Miles 855 Operating hours 58.5		Months 2 1/2 Miles 1491 Hours 81.5		Months 2 1/2 Miles 1778 Hours 77.5		Months 3 Miles 786 Hours 21.8		Months 4 Miles 5,868 Hours 197.2		Months 2 1/4 Miles 4,102 Hours 138.5	
LOCATION OF TROUBLE	DESCRIPTION OF TROUBLE, NUMBER OF OCCURRENCES, AND REMEDY											
Starting		0	Hard starting when hot-pump press. too low (5-25 and 6-5-50) Changed governor. One burner starts. (7-18 to 5-24-50)	4		0		0		0		0
Fuel System		0	Low fuel pressure during hot starts. Loss of prime after stopping. Erratic idling (6-12-50). Burner blowouts. Revised plumbing.	4	Low fuel pressure - clogged filter (9-20-50)	1		0	Occasional sticking of acceleration limiter. Cleaned and new "O" rings installed. (3-28-51)	1	Low initial fuel pressure caused poor starts (7-17-51). Pulse booster installed.	1
Lube System		0	Oil temp. excessive (7-12-50). Added 2nd cooler. Oil leakage at 2nd stage turbine seal (7-12-50). Oil cooler rupture (7-26-50). Revised connections.	3		0		0	Breather oil leakage after engine teardown inspection. (5-11-51). Changed breather.	1		0
Burners	Liners and Nozzle Adapters chafed (5-5-50). Installed new liners.	1	Blowouts (6-26-50). (See Fuel System) Carbon on fuel nozzles (7-21-50).	1	Burner blowouts at closed throttle (10-9 to 10-13-50) Cause not determined. New liners, shells, and cross-fire tube installed.	1		0	Burner blowout (6-6-51) - carbon on fuel nozzle.	1	Small piece of burner liner went thru 1st stage wheel. Repaired by smoothing leading edges of blades. New liners installed.	1
Wheel Rubs	1st stage rubbing after shutdown. Increased clearance (3-22-50). 2nd stage severe blade tip rub. Nozzle ring reground (4-7-50)	2	1st stage shroud weld failure (6-21-50)	1	1st stage blade tip rub from shroud weld failure (9-25-50)	1		0	1st stage rub due to exhaust stack flex joint seizure (6-2-51). No blade failure, wheel repaired.	1		0
Blade Failure		0	1st stage overheating from one-burner starts. (6-21-50) Replaced both wheels.	2	2nd stage blade failure-fatigue near base (9-8-50). Crack found in one 2nd stage blade during engine overhaul (10-20-50). Wheel replaced.	2	1st stage turbine blade and nozzle vane heat-shock cracks and burns. Replaced wheel and nozzles. (9-31-50)	1		0	2nd stage blade failure (7-16-51). This was old-style blade on used wheel from spin pit test with total wheel hours 972.5.	–
Blade Weld Failure		0		0		0	2nd stage blade weld failure (9-31-50)	1	2nd stage blade weld failures. (3-28, 5-11, and 6-8-51)	3		0
Transmission	Power braking reverse clutch too jerky. Reworked air control	1	Lurching during low-speed shifts from driveline wind up. Oil seal failure (5-25-50). Erratic shifting (6-22-50).	3	7-speed Carcomatic oil overheating on Snoqualmie climb (9-5-50). Erratic shifting on hills (9-26-50).	2	Power braking reverse gear clutch flywheel burst (1-3-51). Cause was clutch slipping during hill climb. Reverse transmission rebuilt with clutch omitted.	1	Reverse gear forward ball bearing failed (3-5-51).	1	7-speed shift erratic (6-26-51). Oil seal replaced.	1
Miscellaneous	Engine overheated with under-hood sound-proofing.	1	New-type 2nd stage wheel installed (5-15-50). New 2nd stage wheel installed (7-28-50) after bearing damage from loss of oil (see Lube).	2	Engine overhauled Aug. 1, 1950 and brought up to date. Exhaust mufflers installed. Reverse gear ratio changed from 1:1 to 1.5:1 (9-15-50).	–	During test stand check of overhauled engine (12-6-50), the compressor impeller burst because of fatigue at rivet holes. New design without rivets installed and engine rebuilt.	1	Trailer brake diaphragm failed (5-19-51).	1	Thrust nut backed off 2nd stage shaft (7-3-51).	1

also air cleaner and exhaust system losses in the diesel installation, so that the actual power delivered to the transmission shaft was something like 180 for the diesel compared with 160 for the turbine engine. (2) The turbine also gains in better utilization of peak performance with fewer gear shifts, because of the inherent torque converter characteristics. This is indicated by Figs. 2 and 3.

No doubt most truckers would prefer to have this performance advantage in terms of the better road speed on grades that could be obtained with a turbine engine of higher rating, such as 200 or perhaps even 250 hp, but the effect of this increased power on fuel consumption needs to be kept in mind.

Another reason for desiring a higher power rating with the turbine is to have reserve for hot-day losses. The well-known sensitivity of the turbine to inlet air temperature was quite noticeable in the test truck during hill climbs on a hot day. Fig. 4 shows the amount of this power loss.

Engine Noise and Cooling

Engine noise and cooling are related in the gas turbine installation because the degree of soundproofing built into the engine compartment determines whether or not fan or blower cooling is required to prevent overheating of accessories and other engine parts. Practically all of the test truck operation was done with an open underhood installation with no soundproofing of the compartment. Ventilation from forward motion of the vehicle was found to be adequate without a fan. With the air inlet silencer and a nonrestricting acoustic muffler on each vertical exhaust stack, the noise level is definitely less than for standard diesel-powered trucks. Conversation in the cab is not difficult at wide-open throttle. Acoustic tests with this arrangement showed a combined noise level around the engine hood reaching the 85-decibel range, most of which emanated from engine surfaces other than the muffled air inlet and exhaust openings.

Preliminary experiments with underhood soundproofing have indicated that a further marked improvement in noise reduction is possible, particularly in the high-pitched whine that is unpleasant to some people. However, such enclosures are also good heat insulators, so that with their use forced air circulation is mandatory. The fan power requirement probably will be considerably less than now needed for truck-engine radiators. A really

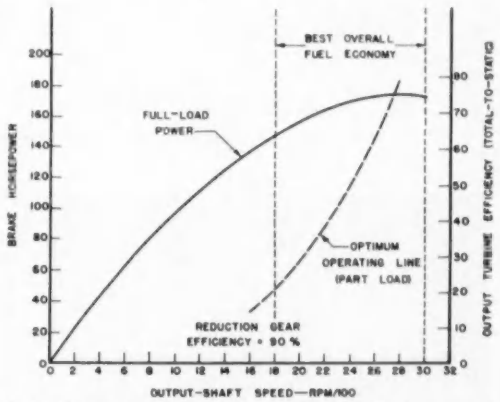


Fig. 1—Engine power and turbine efficiency curve showing range of engine speed for best fuel consumption

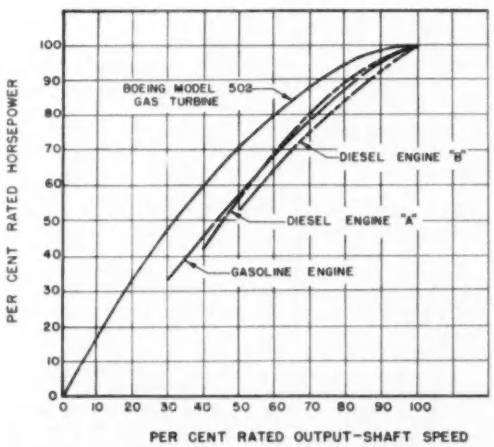


Fig. 2—Horsepower comparison of turbine with gasoline and diesel engines showing superior turbine power at reduced speeds

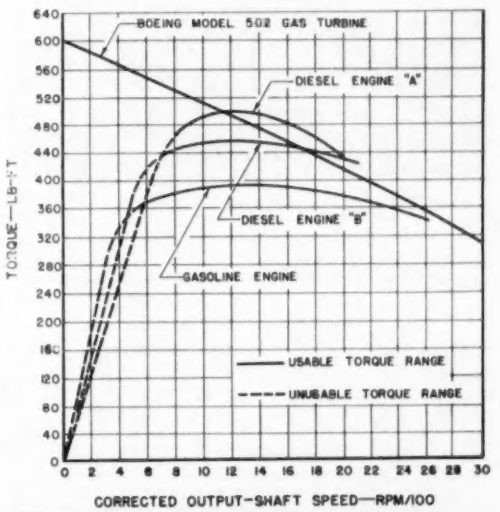


Fig. 3—Torque comparison of turbine with gasoline and diesel engines showing superior turbine torque at low speeds

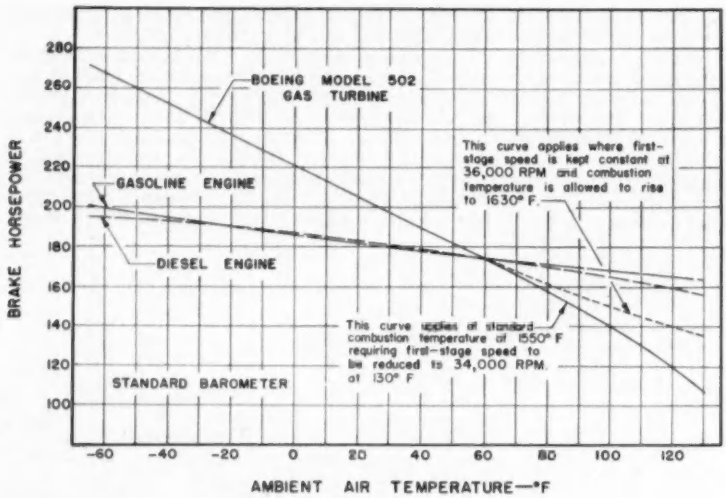


Fig. 4—Loss of turbine power compared with gasoline and diesel engines. Note that equality at high-temperature end requires overtemperature and overspeed for turbine

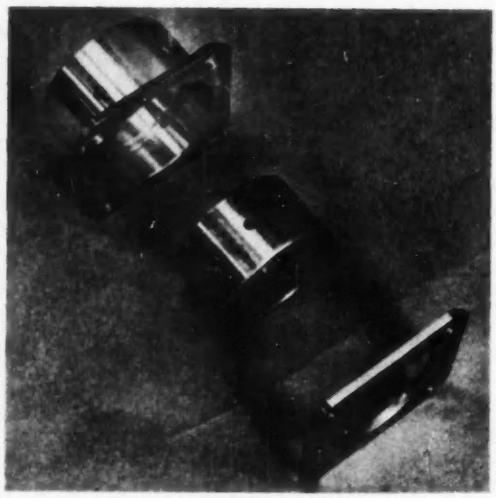


Fig. 5—Floating sleeve rotor bearing

quiet installation, approaching passenger-car standards is, it would appear, a definite possibility.

Fuel and Oil Consumption

From Table 1 it is clear that oil consumption will be negligible in gas turbine operation. Actually, the only consumption of oil involved is that getting out of the breather tube as vapor. This can be considerable if compressor or turbine gas seals leak badly. Some difficulty with oil leakage at these seals has been experienced, but so far this has been effectively cured by minor revisions in the design of the labyrinth seal arrangements. The high shaft speeds of the small turbine are an advantage as far as these seals are concerned, since leakage can be prevented without any rubbing contact. This means that no maintainance is involved, provided design, manufacture, and assembly are correct.

This engine has shown rather complete insensitivity to the fine points of modern lubricating oils. Compounded and straight mineral oils, even hydraulic oil and automatic transmission oil, have been used without there being any appreciable effects except in the flow rate and oil cooling requirements. Viscosity of SAE 10 is normally used but SAE 30 and AN 1010 also have been satisfactory. There is little, if any, oil deterioration after long endurance runs, in spite of the fact that the oil sump capacity is only 4 qt. In this connection, one of the most interesting developments in the turbine is the Boeing-developed floating sleeve rotor bearing, which is shown in Fig. 5. This has proved very reliable and well adapted to the high-speed light load duty peculiar to turbine rotor shafts.

The fuel consumption story is something else again. The test truck averages of a little better than 1 mpg on diesel oil fuel are no doubt very disappointing to operators accustomed to 3, 4, or 5 mpg. From test stand measurement at least 1½ mpg was expected, and this difference undoubtedly lies in the exhaust stack loss already mentioned and in transmission losses resulting from the additional gearing involved in the experimental adaptation of the turbine to an existing truck.

Despite this situation a careful study of all the facts indicated that fuel costs definitely in the competitive range are to be expected. It is felt that this will be brought about by a combination of steps, which will include the following:

1. Reduction of drive line and transmission losses.
2. Reduction of engine installation losses.
3. Design of truck chassis and engine installation to take maximum advantage of the 2500- to 3000-lb weight saving of the gas turbine. This factor, by improving the payload, makes the net return about

the same in the turbine truck as for current diesel trucks for ranges between fuel stops of the order of 450 miles or less. This is for the present model 502 turbine with minimum dynamometer fuel consumption of 1.3 lb per bhp per hr.

4. Raising the thermal efficiency.

This last item is probably the most important—and also the most difficult—but it appears from the truck test program that a major improvement of the order of 30 to 35% reduction in fuel rate is needed. This sounds like quite a development chore but it can be reported that means for this gain in fuel economy appear to be near at hand as a result of successful research work on compressor and turbine design. This statement is based on many hours of painstaking laboratory effort on means of improving the aerodynamic efficiency of the present types of centrifugal compressors and axial-flow turbines, rather than on radial departures in cycle operation or engine configuration. Thus, realization of the benefits of these improvements should not involve major mechanical development problems.

The use of cheaper fuels to compensate for the higher fuel consumption of the gas turbine has attractive possibilities and will remain an important potential asset. However, as long as starting, acceleration, burner liner life, and other fuel supply and combustion problems remain in the more or less critical category affecting the competitive usefulness of the gas turbine, it would appear more fruitful to steer development toward improved thermal efficiency, rather than toward the use of fuels heavier than diesel or domestic burner oil.

Cold-Weather Operation

Since there is no liquid cooling system, it may be expected that the cold-weather problems of trucks powered by gas turbines will be much less severe than with those using conventional powerplants.

Recent tests in the cold chamber have shown that the turbine engine will start at - 65 F with AN jet fuel and diluted libricating oil in the engine sump. The ignition system consists of a spark plug, which combines a glow coil for vaporizing the cold diesel oil with a hot spark for ignition.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Summary of Discussion

IN the discussion, the author brought out some additional points about the turbine engine and the test program.

In answer to a question about variations in turbine power output with changes in altitude, he reported that in the testing done so far—which has been only up to 3500 ft—there has been no noticeable effect. At altitudes of 8000 or 9000 ft, he thought it might be worth taking into account. As altitude increases, he explained, there is a loss in output because of the drop in pressure, but this loss is partly made up by the gain in output from the lower temperature encountered. ["It has now been established that loss of power with altitude is substantially less than for piston engines," according to recent information received from the author.]

He discussed briefly the development of power braking, reporting that, for braking purposes, the propulsion turbine is operated through the reverse gear, so that it turns in the opposite direction from that when driving the truck forward, thus tending to speed up the flow of gases out the exhaust stacks. The power absorbed in braking is dissipated as work at the turbine wheel in opposing the gas forces, and the braking heat is discharged out the exhaust. The amount of braking is controlled by the accelerator.

In one test on an 11% down grade, he put the truck in reverse and opened the throttle wide, which resulted in bringing the truck to a complete stop and then starting it going backwards.

In reply to another question about the acceleration characteristics of a turbine-powered vehicle compared with a standard bus, the author said that the turbine engine can go from idle to full power in 5 sec, which he thought was pretty fast. He said he didn't know how fast modern bus engines accelerate, but suggested that the accelerating qualities of the turbine engine are as good as those of conventional engines.

He explained that acceleration may produce two problems. One is that, if the throttle is opened too fast, the temperature in the turbine may momentarily exceed the maximum for which the engine was designed. For this reason, an acceleration limiting device should be used.

The other problem is what's called "pulsation," or "acceleration howl," which causes a startling noise when acceleration is rapid, but doesn't seem to cause any harm.

R. C. Norrie and W. M. Brown, Kenworth Motor Truck Corp., pointed out that the hydraulic shifting transmission used on the truck is not required. Actually, they said, the truck is now equipped with a high-speed synchromesh transmission of conventional countershaft design, with a dry-plate clutch between the transmission and the engine. It is manually disengaged with a clutch pedal. They reported no perceptible difference for the driver when shifting this combination of transmission and turbine engine, as compared with the same transmission and a piston engine.

Production Men Detail Sound

A SOUND production planning and control system is important to insure full utilization of manpower, machines, and plants. Aircraft manufacturers, suppliers, and representatives from the automotive world discussed many individual problems relating to schedules, methods of control, ascertainment of results, production planning and others.

Organization and defined responsibility of production control varied among the representatives present. However, it was agreed that objectives of a production control system should be:

- Systematic planning of the operations to be performed,
- Organization to execute the plan,
- Methods to ascertain and analyze the results.

These objectives apply whether production control is set up as an independent operating department or functions as a part of the production organization. The tendency seems to point to a program of educating the manufacturing organization to become responsible for internal control.

Questions relating to methods, the effect of shortages, rejections and reworks on schedules were discussed at some length. A schedule establishes need in preplanned sequence and must reflect priority. Respect for schedules, even though they may be past due, can be achieved by indoctrination of the manufacturing organization.

The schedule may either be an actual calendar date or a code system translating a date to numerical or alphabetical designations. The latter appears to be more flexible in that very few physical changes on the order are necessary in the event of a schedule revision.

In the determination of lot sizes for manufacturing, the schedule is one of the critical elements. The rate at which the item is to be produced, the amount ordered, and the cycle time are considered. Cycle time may vary due to space limitations on completed items, fabrication facilities and material conditions. In addition, the lot size may vary for certain parts because of:

1. Price structure of items at contract breaks,
2. Material availability,
3. Degree of change in product,
4. Low cost items suitable for mass production,
5. Parts difficult to store because of size,
6. Lengthy operations making lot size manufacture impractical.

The aircraft industry enjoys an advantage in that the total quantity of articles to be produced is preset and the schedule is usually specified by contract. Thus all planning activity is based on a firm program. In the automotive industry, on the other hand, material purchase and planning often have to precede any contracts or actual offers to buy completed products. One member of the panel representing an automotive manufacturer stated that the schedule and lot size structure was built as follows:

1. Low cost items manufactured on a maximum and minimum basis.
2. Intermediate cost items—a two- to four-week inventory.
3. Assembly line items (engine blocks, frames,) from one hour to two- or three-day inventory.
4. Special equipment—made and ordered by contract requirements only.

With different automotive finished products rolling down one assembly line, the scheduling function becomes an important and detailed plan. It requires grouping of major components, such as several types of cabs, frames, axles, housings, and so forth. The schedules manager knows the number of man-minutes available and may mix lines to balance work loads. The schedule is pre-set three or four days in advance of execution to allow special painting and handling of special equipment to be done beforehand.

In the aircraft industry special pilot or mock-up airplanes are sometimes required to accomplish major changes. And the schedule is advanced to develop the change prior to production effectivity. Most companies stated it was their policy to set up special schedules and controls beforehand to insure complete coordination.

The impact of machine-hour and man-hour load is considered by most companies in making detailed schedules for fabrication shops. One manufacturer stated that the time standards department forecasts future fabrication loads four to six weeks ahead by the type of operation (turret lathes, mills, drills, punch presses, and so forth). It was evident that greater detail scheduling by operation is done in automotive industries.

General consensus of aircraft representatives indicated that a pre-set time span based on previous experience is used for establishing schedules in fab-

Production Control Systems

REPORTED BY

R. L. Anderson, Douglas Aircraft Co., Inc., Long Beach Division

• Panel on Production Control was held at SAE National Aeronautic Meeting, Los Angeles, Oct. 3, 1951, under the auspices of the SAE Production Activity. Panel leader was E. F. Gibian, Chief Industrial Engineer, Thompson Products, Inc.; panel co-leader was J. B. Adams, superintendent, manufacturing control, Long Beach Division, Douglas Aircraft Co., Inc.

rication. This span refers to the time from material furnishing to completion of fabricated part. One aircraft representative stated that two pre-set time spans were used by his company. One span was set for parts of normal complexity and the other for parts requiring lengthy or difficult operations.

Accumulation of shortages and rejections to a pre-set amount before reordering was held to be a practical method of preventing, insofar as possible, an abnormal number of setups in fabrication. Release of these accumulations with a production release or as a separate order on a ship-short basis insures proper priority.

There was general agreement that contract spares should be released with production orders to save separate setups. Although there is a tendency for parts to be taken from spares to fill production needs, most companies have set up controls to reduce this abuse and, in some cases, forbid it. One manufacturer said that spares are considered part of the production package and the sale is contingent to this premise. Another reported that an authorization from the vice-president of manufacturing is necessary before any part made for spares can be used for production requirements.

In cases where the schedule is accelerated due to customer demands, or other reasons, most representatives planned their programs along the following lines:

1. Adjust procurement of material.
2. Planning release—change lot sizes, fabrication schedules, and so forth.
3. System of up-grading personnel.
4. Set requirements for manpower.
5. Procure additional facilities—if procurement dates do not coincide with schedule needs, subcontract or temporarily divert until facilities are received. Facilities should be procured for known rates but with allowances for possible peaks which may exceed present known rates.
6. Set up program for various stages of increase

Listening attentively to W. F. Snelling, superintendent, production control, North American Aviation, Inc., at the Production Control Panel are left to right: Secretary R. L. Anderson, industrial engineer, Long Beach Division, Douglas Aircraft Co., Inc.; J. E. Adams, director of purchasing and planning, White Motor Co.; Snelling; Panel Leader E. F. Gibian, chief industrial engineer, Thompson Products, Inc.; Panel Co-Leader J. B. Adams, superintendent, manufacturing control, Long Beach Division, Douglas Aircraft Co., Inc.; and F. W. Lloyd, superintendent, manufacturing control, Northrop Aircraft, Inc.

so that a complete known package is available for any point of cutoff.

As production schedules increase and manpower and facilities tend to become tighter, the question of subcontract and feeder shop operations come forth. A feeder shop was considered by most representatives to be another home plant operation in a removed location. In general, only slight changes in schedule to account for travel distances make the operation differ from the home plant. A feeder shop is often considered where close coordination is required with the home plant or to take advantage of labor pools outside of reasonable travel distances to the home plant. Feeder shops are also set up where facilities by a private source are not available. A healthy competition often develops between feeder shop and home plant, resulting in marked efficient operations.

Subcontract may be used in place of feeder shop if supervision in the home plant is not available, but the subcontractor possesses a completely staffed organization. Two methods of subcontracting discussed were:

1. Vendor is furnished with fabricated parts and performs assembly function only. At some negotiated point, fabricating tools and any necessary facilities are transferred to the vendor. He assumes full manufacturing responsibility.

2. Engineering information released directly to the vendor—as in the case of a new model—and he plans, tools, fabricates, assembles and delivers the completed end item.

These key measuring points were suggested as means to determine how the execution of a production control plan is being performed:

1. Progress against schedule (unit count);
2. Flow time measurement—used in such areas as planning, tool design and blueprint;
3. Order count—orders in, out and backlog within a week;
4. Line shortage forecast—a first ship-short measurement based on pre-set amount of line supply.

The use of tabulating techniques in shop loading, measurement and order writing was discussed, but a general cautious attitude toward its application was evident. Most representatives present were using tabulating on a limited basis. It was felt that tabulating was useful where functions can be combined for gathering statistical data. Although its use is limited at the present time, further application and sample runs were being considered.

Ceramics, Welding, Bonding Are Topics of Processing Panel

Continued from Page 29

of our old-line top-grade welders have been upgraded to supervisory positions, on the other."

In reply to questions relative to the steps taken to conserve critical materials, it was stated that the aircraft industry is making a large-scale substitution of the titanium-stabilized steels for the columbium-stabilized grades.

Welding of titanium was discussed. Data disclosed showed that titanium can be resistance welded without serious difficulty, and fusion welding is possible where an inert gas atmosphere, such as argon, is provided. The concensus was that no practical method of fusion welding of titanium to other metals has yet been developed, due to titanium's decided affinity for oxygen. Brazing of titanium to other metals also is considered difficult almost to the point of impracticability. Titanium either refuses to wet or develops serious brittleness.

Because the use of titanium is developing rapidly, it was decided that much immediate research is necessary to develop wetting agents and joining processes for this metal.

The use of Rosslyn-type metals (copper covered with low or high alloys) offers exceptional vibration-damping characteristics and should have great demand as a substitute for the more critical metals. Welding difficulties of this composite metal preclude its extensive adoption at present; however it appears that these difficulties will eventually be surmounted.

In answer to a question, it was stated that there is no way of fusion welding galvanized metal, although resistance welding can be carried out with no difficulties.

It was asked why 8630 tubing would not give accurate Rockwell readings following welding and heat-treat. The answer indicated that this material develops a decarburized skin in heat-treat and this soft skin must be removed prior to the Rockwell test.

In resistance-welding inspection, it was stated, the tension-shear test alone is not enough. Progressive companies are turning to the micro-etch process as the preferred test.

Discussion of metal bonding proved that great strides have been made during the past year in this field. It now is possible to bond large areas such as nacelle cowl panels and floor panels together through the use of improved wetting agents and adhesives. It was admitted that surface preparation, especially in the case of aluminum, still is far from satisfactory and research is needed.

Preparation of titanium surfaces for bonding should include a bath of 16% nitric acid and 3% hydrofluoric acid, to last not more than 30 sec. The use of 10% fluorboric acid and 5% hydrofluoric acid also was proposed.

It was suggested that improved tooling is necessary to assure continued development in the bonding field, with liquid- and steam-heated tooling apparently the preferred answer to the problem of hot-press bonding.

Radioisotopes Prove Important Research Tool

You'll Be Interested to Know

Approximately 150 radioisotopes are available for use by qualified workers in science, medicine, industry and education.

Procurement of these man-made radioactive materials from the Atomic Energy Commission is a straightforward procedure. Applicants must:

- Have acquired sufficient training in handling radioactive materials,
- Have adequate monitoring instruments,
- Agree not to transfer the materials to other investigators without AEC permission.

If the proposed use of radioisotopes involves working under field conditions, additional requirements relative to public safety must be satisfied.

Of particular interest to industrial research personnel and administrators is the manner of handling applications where the applicant feels that the possibility of a patent situation may exist. In these cases, such applications are designated "Company Confidential" and—contrary to general AEC practice—no information concerning the nature of the work is made public.

EXCERPTS FROM PAPER BY

George G. Manov and Oscar M. Bizzell

Isotopes Division, Atomic Energy Commission

• Paper, "The Availability of Radioisotopes and Their Application to Petroleum and Automotive Research," was presented at the 1951 SAE National Fuels & Lubricants Meeting, Chicago, on Nov. 1, 1951.

MAN MADE radioactive materials are proving to be an extremely important and useful industrial tool. In addition to their new found uses in petroleum production, they also provide a unique means for studying automotive and petroleum research problems.

Radioisotopes are valuable because of certain singular properties they possess—specificity, sensitivity and versatility. They can be used to "tag" atoms or molecules which can then be identified from identical but inactive species. Sensitivity of the radioisotope technique is several orders of magnitude greater than conventional physical or chemical methods. A radioelement such as carbon-14, for example, can be incorporated into methane, heavier hydrocarbons, fatty acids, phenols, and so forth. Versatility of the radioisotope technique, therefore, is appealing.

Broadly speaking, radioisotopes are being used in two ways:

- As sources of radiation only,
- As tracers to follow a particular process or flow stream.

Applied to Petroleum Production

Radioactive materials have been used to identify the various strata that might be productive of petrolum. A radium-beryllium neutron source, together with a detector and a preamplifier, is lowered into the well. (Absorption of neutrons is high by materials containing hydrogen—shale, oil, and water.) The output of the preamplifier is further amplified and fed to a strip chart recorder which yields a curve showing the intensity of the secondary radiation as a function of the depth of the boring. This illustrates the use of radioisotopes as sources of radiation.

Radioisotopes are also providing a solution to one

of the recurring problems in the petroleum industry —pipe line dispatching. Here the problem is to transport various kinds of oils through a single pipe line, which may be several miles in length, and to deliver each oil to the appropriate storage tank. In the past, careful testing of the oil at frequent intervals has been necessary to determine the arrival of the interface.

California Research Corporation has experimented with injecting a small quantity of radioactive material into the pipe line at the interface between the first and second types of oil. Locating the interface several miles downstream, with the aid of a Geiger counter, thus becomes a comparatively simple matter.

It is in the fields of reaction mechanism and reaction kinetics that the specificity, sensitivity and versatility of radioisotopes are most evident. Carbon-14 has been used to study the mechanism of the Fischer-Tropsch synthesis of gasoline from carbon monoxide and hydrogen. This process, first developed in Germany, utilizes a mixture of carbon monoxide and hydrogen which is passed at high temperature and pressure over a suitably prepared catalyst. The actual reaction mechanism has been in doubt for some time; one theory postulated the formation of iron carbide as an intermediate in the reaction; according to a second theory, the catalyst offered a suitable surface at which the reaction could take place but did not of itself assume any other role. The use of the radiocarbon at the Mellon Institute provided a unique method for testing the validity of the first theory.

Radioisotopes are being put to a wide variety of uses in the automotive research field.

Determination of the wear of piston rings is one striking example. Conventional piston rings are made radioactive by subjecting them to neutron bombardment in the Oak Ridge reactor. The active rings are then fitted to the pistons using proper shielding and monitoring techniques, the engine assembled, lubricating oil added, and the motor started. Sensitivity of the radioisotope method is so high that wear of the rings can be detected in the first few minutes of running time. (See Fig. 1) It should be noted that it is not necessary to dismantle the engine and that both the rate and the total wear can be measured readily.

Experiments were made primarily to determine engine wear as a function of the type of lubricating oil used, but the same experimental setup could be used to determine the effect of octane number, sulfur content, load factor, and water jacket temperature on the rate of wear.

Although these experiments were made by an oil company in its search for a better lubricant, an automotive research group might equally well study the effect of variations in the chemical composition or physical properties of the piston ring, the durability of inlet and exhaust valves, the scavenging of the exhaust gases, the deposition of iron (or of lead) along the exhaust manifold, the rate of wear of water pumps, the corrosion of radiators by water and by various anti-freeze mixtures, and so forth.

Chrysler, for example, has studied the life of the breaker points used in distributors by the use of radioisotopes. Breaker points are sent to Oak Ridge for activation. It is thus possible to carry out in a few months a program which would take years by conventional methods.

And Goodrich is using the radioisotope technique to measure the rate of wear of tires on road surfaces. A small amount of Phosphorus-32 is incorporated into the tire during the time of manufacture. The tire is then mounted on a vehicle and driven over various types of surfaces. The roadway is later monitored with a Geiger counter or by autoradiography. Two other methods can be used: a small portable Geiger counter can be mounted close to the ground and shielded from the radioactive tire, or a vacuum scoop and filter can be placed behind the tire and approximately 2 in. above the road to collect the rubber worn off. Subsequent analysis is made in the laboratory.

These brief descriptions and examples of applications for radioisotopes may suggest to alert engineers and scientists many more interesting and fruitful lines of investigation.

(Paper on which this abridgement is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

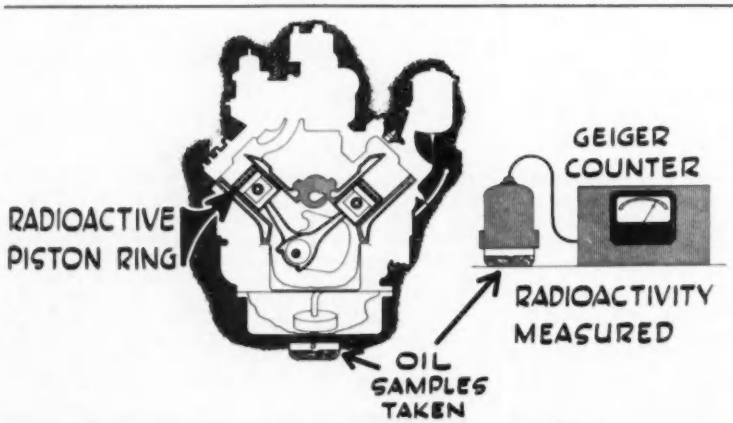


Fig. 1—The radioactive tracer technique permits measuring 1/100,000 ounce of engine wear

Forming Panel members concentrating on a question from the audience are (left to right): Panel Secretary Donna M. Ohm, methods analyst, Santa Monica Division, Douglas Aircraft Co., Inc.; G. E. Larsen, tool development engineer, Northrop Aircraft, Inc.; B. K. Bucey, tool design manager, Boeing Airplane Co.; Panel Leader O. A. Wheelon, production design engineer, Santa Monica Division, Douglas Aircraft Co., Inc.; Panel Co-Leader J. S. Corral, general foreman, machine forming, North American Aviation, Inc.; and B. F. Raynes, chief tooling engineer, Rohr Aircraft Corp.

Panel Acquaints Subcontractors with

Forming Characteristics

REPORTED BY

Donna M. Ohm, Methods Analyst, Douglas Aircraft Co., Inc.

• Panel discussion on Forming was held at SAE National Aeronautic Meeting, Los Angeles, Oct. 3, 1951, under the auspices of the SAE Production Activity. Panel leader was O. A. Wheelon, production design engineer, Santa Monica Division, Douglas Aircraft Co., Inc.; panel co-leader was J. S. Corral, general foreman, machine forming, North American Aviation, Inc.

THE Forming Panel was set up to acquaint prospective subcontractors with new developments in production forming methods, new tools, and new equipment that have evolved in the transition period since the early 40's. The airplanes of today are so varied in design, function, and appearance, that many problems have been created concurrent with each new design. These problems have demanded the use of new tchniques, modifications to existing equipment, or the development of new equipment for their solution.

The advent of higher-strength alloys such as 75S and of titanium, the widespread use of the stainless steels, and the use of more complicated shapes have created new forming problems. Many of these can be solved by the use of higher pressures. In the hydropress, present equipment may be adapted to increased pressures by (1) cutting down the size of the rubber container and concentrating the pressure in a smaller area, (2) increasing the press size, or (3) increasing the pressure locally by trapping the rubber by the use of wedges or plugs. Pressures as high as 40,000 psi have been employed in certain special applications, but pressures of this magnitude are not required on many parts. The lower limit for press pressures has been increased from 1000 psi up to 10,000 psi on test runs, but it is uncertain whether these higher pressures are justified. It is felt that the average aluminum-alloy sheet-metal part requires only about 3500 psi for satisfactory forming with little or no additional handwork.

Higher pressures in the hydropress are a great aid in producing many parts of increased size, thickness, varying contour, or sharper bends, but are of no value in producing parts with high shrink flanges. To form these parts on the hydropress, auxiliary means such as draw clips, wedges, or dams must be employed to restrain the blank and prevent buckling.

Other methods of forming parts with the use of rubber and high pressures and a single male die have been developed recently in the Marform, Hydroform, and Hydraw processes. These processes are essentially the same, utilizing high-pressure rubber or hydraulic forming with the aid of a double action draw plate. In the Marform and Hydroform pro-

cesses, the pressure can be controlled during different stages of the stroke, thus better controlling the flow of metal over the die. These presses are particularly suitable for domes of constant thickness, deep draw cups, and similar parts. Die cost is low since only one die—which can be made of relatively inexpensive material—is required. It is not contemplated, however, that these presses will replace hydropress, drop hammer, draw press, and other methods of forming but will supplement these pieces of equipment, particularly for those shapes which are difficult or require excessive staging.

The emphasis placed on these new means and processes was challenged on the basis that to date this equipment has only been produced on a relatively small scale and cost is extremely high. It appears that exceptionally large equipment will be necessary to handle many of the newly designed parts, and this may make the cost prohibitive. Most large parts are still formed on the drop hammer, the brake, or the stretch press. With the drop hammer, parts can be rehit after heat-treatment to remove heat-treat distortion and to size accurately.

There is also a trend developing to use cast-iron and steel dies with a lead punch on the drop hammer to achieve greater accuracy and longer die life. Also titanium can best be formed on the drop hammer or draw press with heated dies and materials.

In comparing these various processes, we see that they all have a place in production forming. It is not felt that any one method will replace all others. Some parts are more easily adapted to the hydropress, others to the power brake, drop hammer, or draw press, and still others to the more recently developed high-pressure presses.

Another type of production forming, the use of the various stretch presses, was discussed by the panel. The main principle in stretch wrap forming is to preload the part almost to its yield point, to wrap the part around the die, and to stretch the material beyond its elastic limit to set the part.

The advantages and disadvantages of the Hufford with its independent arm movement compared to the Cyril Bath roto forming for extrusions were investigated; also the Sheridan, Erco, and Hufford sheet stretchers were discussed. There were no definite conclusions as to the superiority of one machine over the others since they all have their place, but there was definite agreement as to the procedure to be followed in stretching various parts. A few parts, such as mild-contoured extrusions, can be stretched in a single operation with the use of compensating blocks; while most stretching operations require a preliminary stretch, solution heat-treatment, and a final stretch on net blocks. Grade 75S is usually not stretched in the T6 condition because of its vulnerability to edge breakage and jaw breakage. Curved jaws and hot dies tend to alleviate this difficulty, but wisdom of stretch forming 75S in T6 condition is still controversial.

It was also pointed out how stretching operations can be accomplished on the hydraulic brake or conventional hydraulic presses by adapting special jaws to the press to retain the sheet. Such a modification of existing equipment will permit stretch forming of extra large sheets or tapered skins where high tonnage is involved.

Another valuable aid to stretch forming, particularly of aluminum-alloy parts, would be the application of refrigerated forming techniques since greater uniform elongation characteristics are obtained in some materials at lower temperatures. Refrigerated forming, however, is in its preliminary stage of development.

Die quenching was another recently developed method of forming investigated. The parts are formed in the die, solution heat-treated, and transferred rapidly back to the die and quenched by the die to finish form and set the part. The end result gives a part free of springback and deleterious residual stresses. Tests are still in progress to determine the most suitable die material and techniques to be employed, as well as the mechanical properties that can be attained by this method.

It was not felt that the purpose of the panel session was to settle all forming difficulties and point out a clear straightforward solution to all problems. This cannot be done. There may be several different solutions; there may be several opinions as to the "perfect" solution, and each one may be backed up by sufficient reasons for its preference over all other methods. What the panel attempted to do was to present an exchange of ideas and high points concerning production forming that may serve as a guide to the manufacturer.

Room Applications for
1952 Summer Meeting
Are Now Available

Official applications for rooms at The Ambassador and Ritz-Carlton in Atlantic City, N. J., for the 1952 SAE Summer Meeting, June 1-6, were distributed to the SAE membership late in January as an enclosure with the program of the SAE National Passenger Car, Body, and Materials Meeting.

"Blanks have been distributed several months earlier this year," E. H. Kelley, chairman of the SAE Meetings Committee, announced, "to give both SAE members and the two hotels more time to arrange suitable accommodations."

Room applications will be confirmed in order of the receipt of official blanks properly executed in the office of the Housing Committee, The Ambassador, Atlantic City, N. J.

Members desiring additional blanks may secure them by applying to the Housing Committee or to SAE Headquarters.

(4) Easy Ways To Improve Fuel Economy

BASED ON PAPER BY

Max Epps, General Petroleum Corp.

W. S. Mount, Socony-Vacuum Oil Co., Inc.

• Paper, "Things We Learned from the Stock Car Economy Run," was presented at SAE Central Illinois Section Meeting, Peoria, on Sept. 24, 1951.

TECHNIQUES used by drivers in the 1951 Stock Car Economy Run produced results averaging 1.8 mpg better than in 1950—despite more stringent rules. Included among the noteworthy rules followed by these expert amateur drivers were:

(1) Driving the Road Ahead

Driving the road ahead was one of the most important rules. Approaches to traffic signals were made so that shifting or stopping was minimized.

Absolute minimum use of the brakes was an indication of driving the road an adequate distance ahead.

(2) Holding Down Engine RPM

Starting and acceleration methods were aimed at holding down engine rpm. With manual gear shift, the change from first to second was made almost as soon as the car started rolling. And the shift to third was made at as low as 5 to 7 mph. The result was diametrically opposite to common "jack rabbit" starts.

(3) Running Starts on Hills

The hill climbing techniques used varied with the type of transmission. In general, however, all cars got off to a running start by speeding up gradually on the approach to the foot of a hill. This running start helped to carry a car over a hill with less power demand. Then, rather than trying to maintain a constant speed up the hill, the speed was allowed to drop by holding a constant or slightly diminishing throttle.

Considering hill climbing alone, it probably would have been best to just get over the top of a hill at a very low car speed. On the other hand, considerable gasoline was saved by a relatively high speed run downhill.

Cars with automatic transmissions have a fairly free coasting tendency even when maintained in normal drive. To take advantage of this coasting effect, therefore, many drivers accelerated when nearing the top of a hill—even though close to full throttle was often required.

(4) Easy on the Throttle

An easy foot on the throttle proved to be a good rule. With this end in mind, a number of drivers emphasized the need for a comfortable position and good posture. The seat should be set the correct distance from the controls so that the driver's foot rests easily on the throttle. Throttle linkage must be responsive to slight changes in throttle position. The foot should rest so that—when traversing bumps in the road—the leg will not bounce up and down, thus fluctuating the foot throttle. In fact, some drivers considered a constant foot throttle position so important that when they wished to get a 1 mph increase in speed, they just thought more foot pressure without positively moving their feet.

While few drivers will attain par—just as few golfers attain par on a golf course—Economy Run "par" figures serve as a target at which to shoot. Observence of these driving rules will help motorists reach this goal.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

What Diesel Users Want

RECENTLY, representatives of three industries using diesels told what they expected from the engine manufacturers in the next few years.

Each speaker mentioned design features and services from the manufacturer that his industry considers particularly important.

These are shown in the accompanying tabulation. The paper on which it is based is, "What Is Expected of Diesel-Engine Builders in the Foreseeable Future," presented at the SAE National Diesel-Engine Meeting, Chicago, Oct. 30, 1951. The industries and their spokesmen are:

I. Strip Coal Mining

H. N. Hicks,
Truax-Traer Coal Co.

II. Heavy-Duty Highway Transportation

O. A. Brouer,
Swift & Co.

III. Heavy Construction

H. H. Everist, Jr.,
Western Contracting Corp.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

I. Strip Coal Mining Industry

1. Dependability and as near 100% availability as possible, despite severe operating conditions.

2. Development of a new unit to meet the following specifications:

(a) 400 hp.

(b) Naturally aspirated.

(c) 70-ton payload.

(d) Ability to keep in line with present 20- and 40-ton units.

(e) Torque converter and automatic transmission will probably be needed with this unit. Present difficulties with torque converters include:

(1) Excessive heat in the converter.

(2) Excessive fuel consumption, caused by a loss of power in the converter.

(3) Excessive breakdown of lubricating oil, caused by temperature fluctuations in the powerplant.

(4) Too many "do's" and "don't's" for the driver to remember.

from Diesel Manufacturers

II. Heavy-Duty Highway Transportation Industry

1. Further reductions in weight, which could be accomplished by:

(a) Use of lighter alloys.

(b) Further improvements in the efficiency of the engine.

(c) Even greater increase in torque and horsepower output by stepping up the engine speed.

2. Quietness and smoothness, as well as absence of smoke and smell.

3. Lower initial cost: In the medium- and heavy-duty fields, the price of a diesel engine installed in a tractor is $1800 to $2500 more than that of a gasoline engine of comparable size.

4. Lower maintenance cost.

5. Easier cold-weather starting, because the cost of building storage facilities is almost prohibitive.

6. Elimination of external lube oil lines. This applies to the engine as mounted in the chassis with whatever lube oil filters and coolers are required and the air compressor installed.

7. Built in method of oil cooling.

8. Automatic shut-off upon failure of lube oil supply.

9. Improved fuel consumption.

III. Heavy Construction Industry

1. Dependability and availability, despite severe operating demands.

2. Operation in all climatic conditions.

3. Simplicity of design to give simplicity of repair.

4. Installation of multiple filters and strainers in lube and fuel oil systems.

5. Small water filtering and softening attachments in cooling system of each engine.

6. Engine accessories should be integral parts of the engine and located as conveniently as possible for maintenance.

7. Torque converter should be offered with standard engine lines in completely engineered package, for the various installations required.

8. Engines should not be overrated: 200 rpm reduction has been found, on the average, to increase engine life by 27%.

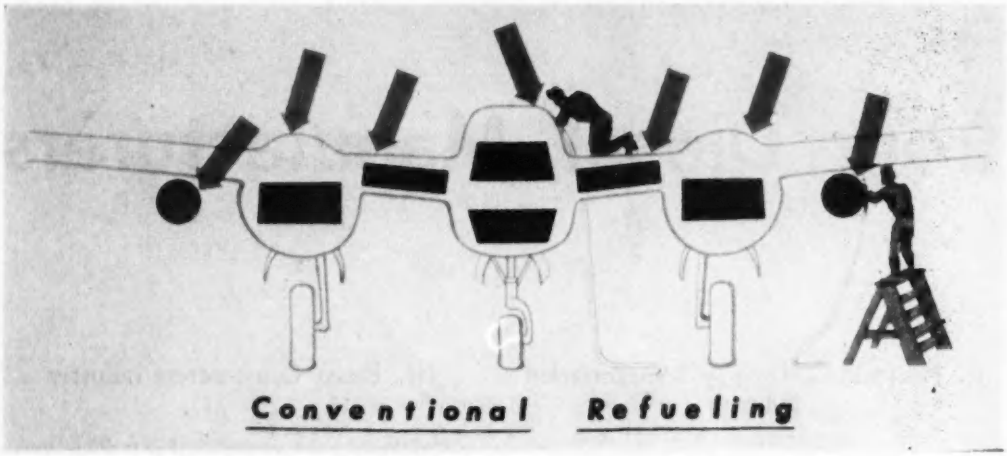
9. Pilot models should be tested under the severe conditions met in actual service.

10. Manufacturers could help operator by:

(a) Engineering installation of new units.

(b) Instructing operator's personnel on proper operation and preventive maintenance of new engines.

(c) Provide followup service to check operation of equipment in the field.



Pressure Systems Speed

Refueling Time

Lebow: One of the most imperative reasons for incorporating pressure refueling systems to military aircraft was the time involved in refueling. In 1944, conventional aircraft pumping equipment generally delivered from 50-90 gpm through a 1½-in. hose with a pump pressure of 35 psi. Even if all tanks of an airplane were refueled simultaneously, at this rate it would take 56 to 100 min to fill a 5000-gal capacity airplane. For military airplanes, this could be prohibitive to the possible extent of seriously hampering a "maximum effort" bombing mission.

I have chosen a 5000-gal capacity airplane merely to illustrate the point. Even the B-29 (now superseded by the larger B-50) has a greater capacity, and the B-36 has a capacity more than five times as great.

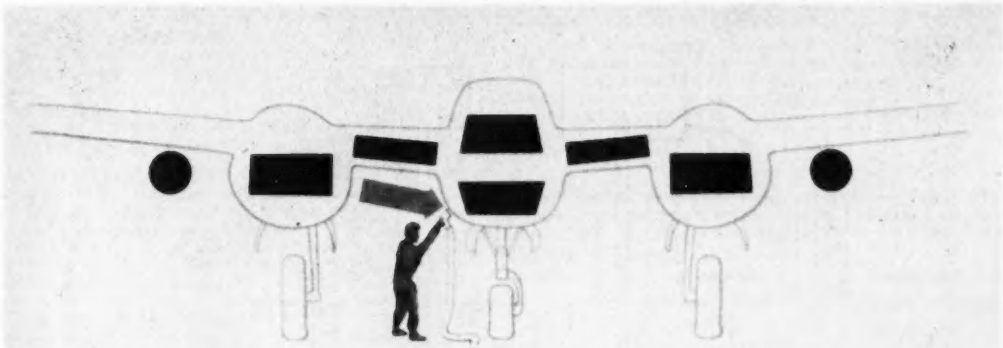
Burns: During the past war, South Pacific B-29 bomber squadrons often had to work all of their available refueling equipment and ground-crew personnel day and night for periods up to five and six days in order to refuel a group for a single long-range bombing mission. Now, with pressure refueling, the B-50 returning from a mission can be refueled overnight and be ready to fly a long-range bombing mission the next morning.

Refueling Rate

Lebow: In order to refuel the airplane in the shortest time, it is important to have fuel flowing to all tanks to be refueled during the entire refueling operation. This also means that all tanks will reach their full position theoretically at the same time. This can be accomplished within practical limitations by proper selection of the line sizes to each tank and proper size of components. If necessary, thin-edge orifice plates or even choke venturis can be installed, although from maintenance and weight standpoints, it is more desirable to accomplish the desired flow rates by design of the basic system.

In the system of Fig. 1, if it is desired to fill the airplane at 600 gpm, and the main tanks are assumed to contain 250 gal each, then the shortest time to accomplish this will be 9000 gal ÷ 600 gpm or 15 min. The main tanks should be refueled at 1750 gal ÷ 15 min or 117 gpm, No. 2 auxiliary tank at 1000 gal ÷ 15 min or 67 gpm, and No. 1 and No. 3 auxiliary tanks at 500 gal ÷ 15 min or 33 gpm. Flows in excess of these indicate excessive line sizes with resulting unnecessary cost and weight in addition to increased overall refueling time.

Bartlett: In the typical aircraft fuel system arrangement such as that presented in Fig. 1, detailed design analysis



Single-Point Pressure Refueling

Refueling of Military Planes

EXCERPTS FROM

PAPER* BY	DISCUSSION BY	DISCUSSION BY	DISCUSSION BY
R. H. Lebow	**P. M. Bartlett**	**Maj. L. G. Burns**	**P. A. Wood**
Parker Appliance Co.	Navy Bureau of Aeronautics	U. S. Air Force	United Airlines, Inc.

* Paper "High-Speed Pressure Refueling of Aircraft" was presented at SAE National Aeronautic Meeting, Los Angeles, Calif., Oct. 5, 1951. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.

will show that, to achieve simultaneous completion of filling, the flow resistance of the lead-in line from the fueling manifold to the inboard main tank must equal the combined resistance of the lead-in line to the outboard tank and the section of fueling manifold between the two tanks. To satisfy fully the simultaneous completion of filling objective would tend to dictate an absurdly large section of manifold between the inboard and outboard tanks.

If the airplane is of a capacity which requires the entire fueling process to take place at the maximum pumping rate, such as 600 gpm for Air Force equipment, then line sizes are dictated by this requirement and fully meeting the requirement will tend to bear out that objective of simultaneous completion of filling. From a weight and line-size viewpoint, however, it is questionable that we can afford the penalty to the aircraft.

As a specific example, an analysis of one large airplane having a fuel system arrangement very similar to the main tank arrangement in Fig. 1 showed a total fueling time on the order of 17 min, with the inboard tanks completing filling in approximately 12 min and the outboard tanks completing 5 min later.

If the concept of simultaneous completion of filling at a rate corresponding to the starting rate were applied, it would have resulted in a filling time reduction from 17 min to approximately 16 min. To accomplish this without a major redesign of the system would have required a 50% greater pressure at the fueling nozzle inlet. On the other hand, to accomplish this at existing nozzle inlet, pressure would have required that the 2½-in. fueling line to the outboard tank be increased to the order of 4-in. diameter. Neither of these considerations could be justified in any

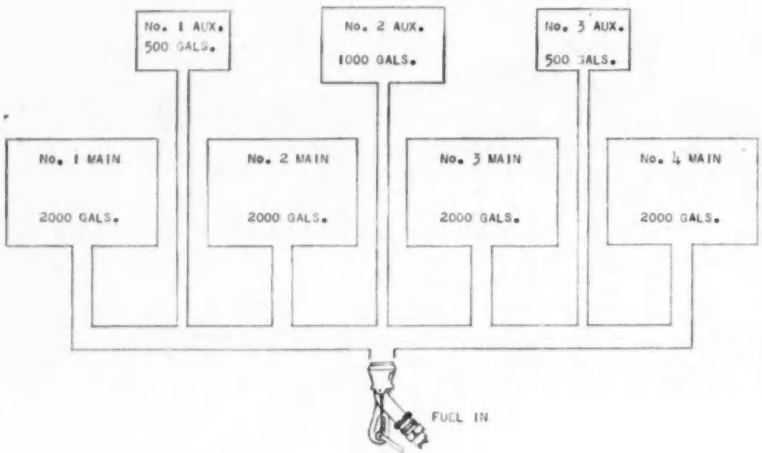


Fig. 1—Hypothetical airplane fuel system of 10,000-gal capacity, showing distribution of fuel prior to refueling. For ground refueling, it can be assumed that each main tank will have retained 10% of its capacity or 250 gal of fuel

conceivable manner for so little gain in fueling time.

Lebow: You get the shortest fueling time when all tanks finish at the same time, but it may not be the optimum arrangement.

Design Philosophies

Lebow: The requirement for the types and numbers of devices to shut off the flow of fuel to each tank are based on a large factor of safety, since failure to shut off fuel flow when the tank has become full may result in excessive stresses on the tank and surrounding structure.

The Air Force requires at least two independent devices per tank, and while it prefers that both devices be non-electrical it makes this mandatory on at least one of the two required units. This is based on experience with both electrical and hydraulic types of equipment. The two USAF-required shut-off devices per tank must be fail-open. Reason is that it is desirable to have a device fail open when the airplane is to be refueled in flight so that fuel can still be induced into that tank either allowing the other device to control the fuel shut-off or (not desiring to rely on a single device) inducing a measured amount of fuel to prevent overfilling the tank. While this procedure may be necessary for inflight refueling, the Air Force reasons that for ground refueling if a valve fails it would be better to have it close. In this way no fuel can enter the tank and the airplane can either take off without fuel in this tank or its take-off can be delayed while the faulty shut-off device is replaced. Accordingly, the Air Force requires the use of at least one fail-close shut-off device per tank where the airplane will be refueled only on the ground. The use of a fail-open device in conjunction with a fail-close device, however, appears to contradict the purpose of the fail-close device, since failure of the fail-open device will result in opening of the shut-off valve.

Since the Navy's refueling will generally be conducted from the deck of a carrier, the Navy will accept either the fail-close device, in which case only one such device per tank is necessary (since if two were used and one failed the other could not be used anyway), or two fail-open devices. The use of a fail-close device is not allowed, however, in the case where the shut-off device is also used in the normal fuel transfer system since it is considered vital that transfer must not be rendered inoperative in the event of failure.

While fail-close devices can be built, their additional complication over the fail-open devices generally makes it more desirable to use two fail-open devices to advantage. Furthermore, with fail-close devices, a failure generally means that the airplane cannot take off immediately and must be repaired. Particularly on the deck of a carrier where other airplanes are readying for take-off and space is at a premium, this airplane might become a serious obstruction. On the other hand if two fail-open valves are used and it is determined during the pre-check that one is faulty, it is still possible to induce fuel into the tank.

The Navy requires pre-checking also except where a fail-close device is used. However, in lieu of pre-checking, a signal system to warn the servicing operator of a failure prior to, during, or upon completion of the refueling operation will be acceptable. The writer does not believe this latter requirement incorporates a sufficient safety factor since it is conceivable that both shut-off devices may have become inoperable since the last refueling (particularly if some time has elapsed), and upon refueling the operator would receive a signal that the devices had failed after the tanks had burst.

The Air Force goes still further in its desire for maximum safety and requires that means be provided for determining whether at least one and preferably both of the shut-off devices are in working condition either prior to or during the early stages of the refueling operation. This is the "pre-check."

Bartlett: Mr. Lebow has presented an interpretation of the requirements in terms of equipment characteristics as we know them today. The Navy's basic requirements are not in terms of "fail-open" and "fail-close" or electrical versus non-electrical equipment, but rather are expressed in terms

of ultimate design objective. These requirements are:

1. No single failure in the pressure fueling system shall jeopardize the tanks or aircraft. Mr. Lebow cites a possibility of compound failure as one argument against a so-called fail-close valve system. However, even though this example might be a real possibility, design for compound failure is not compatible with current military aircraft design practice and the line must be drawn somewhere.

2. Any failure must be readily evident to the fueling operator, or if not readily evident, means must be provided for indicating a failure to the operator prior to, or during, or immediately after completion of the fueling operation. The first part of this requirement was not explicitly stated by Mr. Lebow, but rather was presented as an interpreted requirement that there need be no physical precheck for a fail-close system. The concept of indication of failure at completion of the fueling operation, which was questioned by Mr. Lebow, is considered compatible with the philosophy of not designing for compound failure.

3. A failure of the pressure fueling system shall not compromise the fuel-transfer system. (Although specific requirements for flight refueling have not been established by the Navy, it is expected that this latter requirement will also apply to the receiving of fuel in flight.)

To cite a specific example of the advantage of design by objective rather than by specifying the type of system which may or may not be used:

In one Navy airplane, the pressure fueling system installation also serves as the transfer system, but the level control is completely electric; it combines the features of both fail-open and fail-close components, and yet it satisfies, in a relatively light-weight and simple manner, the first and third design objectives. The ingenuity displayed by the fuel system designer, in this instance, could not have come about if he had been told that he must use a dual system, one of which could not be electrical.

Lebow: My only argument against fail-close devices is that when they fail, you can't get fuel in as with fail-open.

True, you can't design airplanes for compound failure. But you can get dual reliability. You can provide for a check to see that both devices are working before fueling.

Burns: The Air Force requirements for pressure refueling are simple. All that we require is a rugged, simple, safe system that will do the job most expeditiously. By rugged, the Air Force desires a system that will withstand daily service use. By simple, the Air Force wants straightforward installations capable of fueling and defueling operations. By safe, the Air Force requires surge protection combined with adequate shut-off valves in each tank utilizing a suitable pre-checking method.

Weight

Bartlett: For the pressure fueling system designs which I have had the opportunity to review, I have become both alarmed and disappointed at the apparent weight penalty. The method of pressure fueling originally envisioned in the Navy was based upon the system currently in use by some airlines where a minimum of level control valve equipment is installed within the aircraft. This system promised weight penalties of the order of 25 lb per 1000 gal of fuel capacity.

When the Air Force also decided to use the National Aircraft Standard $2\frac{1}{2}$-in. bayonet flange for its equipment, it became possible to achieve the obviously desirable feature in Navy aircraft of being able to be serviced from any military equipment. The decision was then made to change over to the internal tank-level control system.

Fueling system weight resulting from this type of system design has been varying between 50 and 100 lb per 1000 gal of fuel capacity for typical naval aircraft. These weights are considered an excessive penalty, even though the need for the system is real. It is hoped that, with further design efforts, this weight penalty can be appreciably reduced.

Lebow: This figure of 50 to 100 lb per 1000 gal applies only to multi-tank fighters. For transports, bombers, and certain fighters, the weight penalty is probably even less than 25 lb per 1000 gal.

Airline Application

Wood: The size of the fuel system in a commercial transport is dictated by the longest non-stop schedule against adverse head winds. Since this is a rare occurrence the fuel system is never completely refueled at any stop. For example, on our Chicago-Los Angeles operation we use 3600 gal maximum. Of course, some fuel is always in the tank so that it is not necessary to refuel this total amount. In fact, the average fuel placed abroad a DC-6 at each refueling stop is 1230 gal per flight. With our present schedule of stops from 30 to 40 min, fueling is not the critical item. The critical item is still the loading and unloading of passengers and passenger service equipment.

At present we are utilizing 80 to 100-gpm trucks and a few of the latest 200-gpm trucks. This equipment serves adequately. All replacement trucks obtained, of course, are of the latest 200-gpm type.

On future jet aircraft with fuel systems of 7000 to 8000 gal for domestic operation, assuming the present average of 30% of the total capacity being loaded at each stop, would only require 2400 gal. A 200-gpm truck could handle this in 25 min for actual fueling plus 5 min for the positioning of the equipment. You will note that 2400 gal is not put in the airplane at the rate of 200 gpm since time must be allotted for measuring the amount of fuel in the tank as it is gassed and moving from tank to tank. On an overwater operation the requirement would probably be for 60% of the system to be filled at each stop or 4800 gal. From the foregoing, it can be seen that the requirements for commercial aircraft are not as stringent as those for military aircraft, and since the ability of an airplane to perform successful commercial operation is based on its ability to haul payload, any additional weight such as would result from an installation of single-point refueling must pay its way.

On the commercial airliners some system must be provided for readily measuring the amount in each tank and controlling the amount of fuel loaded. This would require, in addition to the items in the present single-point refueling system, some additional valving and fuel measuring means. However, from the personnel standpoint and the reduction of damage to the leading edge of the wing some revision of ground refueling is needed. I believe new ground refueling systems will be multiple-point rather than single-point. Multiple-point systems allow a greater total refueling rate for a lower system weight. In order to simplify the refueling of commercial transports, the airplane manufacturer should make every effort to minimize the number of tanks so that the number of refueling positions is minimized and the simplest system results.

Lebow: Although refueling time is not critical for the airlines, safety is. And—don't forget—pressure refueling is safer than other systems.

New Technique Simplifies

Evaluation of

PRECOMBUSTION reactions play an important role in engine operation. A convenient method for evaluating their effect in a normally firing engine is to measure the heat of precombustion of the fuel under the same operating conditions but with delayed ignition. Using this technique, it has been found that:

- Liberation of heat during the precombustion period may account for 10% of the total heat of combustion of the fuel.
- Addition of tetraethyl lead to a fuel does not affect the rate of liberation of heat over most of the precombustion period. But it is effective in either postponing or eliminating the onset of autoignition or knock.
- Within each fuel-type group, increase in octane number lowers the total heat of the precombustion reaction. However, the magnitude of this heat for each fuel is not specifically related to the octane number.
- Presence of precombustion reactions in an engine operated at delayed ignition results in substantial power increase without necessarily affecting the knocking characteristics of the fuel-engine combination or the total heat liberated by the fuel.

The present study of precombustion reactions was carried out in three phases. In the first—an investigation of the precombustion properties of several hydrocarbons in the absence of an advancing flame front—ignition timing was set at 30 deg after top center. (This corresponded approximately to the latest ignition timing which permitted the engine to operate without misfiring.) These experiments are referred to as *delayed ignition* tests. With this type of investigation, data are relatively easy to interpret since the precombustion reactions occur before the flame front is established in the combustion chamber.

In the second phase of the work—a study of the behavior of fuels under more typical engine operating conditions—ignition timing was set at 15 deg before top center, which in this engine was approximately 5 deg retarded from the maximum power timing. These experiments are referred to as *normal ignition* tests. Data collected in these tests are considerably more difficult to interpret than delayed ignition data. It is, however, very important to carry out this type of investigation to determine whether the results obtained in the delayed ignition tests are applicable to cases of practical interest. In both cases, pressure-time data were obtained with balanced pressure equipment.

The third phase of the experimental work was concerned with the relationship between precombustion reactions and power development over a range of ignition timings.

Delayed Ignition Tests

Delayed ignition tests were carried out, and the heats generated by precombustion reactions were calculated.

Fig. 1 shows both the measured combustion chamber pressure and cumulative heat evolved by the charge (as a function of crank angle) for primary reference fuel blends of 40, 45, 50, 60, 70, 80, and 100 octane number. Also shown is the corresponding curve for diisobutylene (dib), useful for reference purposes since this fuel does not undergo precombustion reactions (nonreacting).

The heat calculations were based on a value of zero at a crank angle of -20 deg. Since engine conditions were maintained nearly constant during all tests, it is felt that prior to -20 deg no significant differences in heat effects should occur for the various fuels. The spread of values for heat liberated in the region before -20 deg is, therefore, a measure of experimental variation.

A horizontal line on the heat-time graph represents an adiabatic process. The lowest curve, showing the behavior of dib illustrates the effect of heat transferred from the hot fuel-air mixture to the colder walls. Up to +30 deg, the point of spark ignition, this curve has a generally downward trend, but after the initiation of combustion by spark, the burning of the fuel results in the generation of heat and the consequent upswing of the curve.

It should be noted that the curves for the 40, 45, and 50 octane number primary reference fuel mixtures exhibit the phenomenon of auto-ignition. The 40 octane number fuel autoignited heavily under the selected engine conditions, while the 50 octane number fuel exhibited borderline autoignition. The fuels of octane number greater than 50 did not autoignite.

Inspection of the curves reveals that—from the standpoint of heat liberation—there are three distinct phases in the reactions undergone by these

Precombustion Reactions

EXCERPTS FROM PAPER BY

E. B. Rifkin, C. Walcutt, and G. W. Betker, Jr.

Research Laboratories, Ethyl Corp.

• Paper, "Early Combustion Reactions in Engine Operation," was presented at the 1951 SAE National Fuels & Lubricants Meeting, Chicago, on Nov. 1, 1951. (This paper will appear in full in SAE Quarterly Transactions.)

hydrocarbon-air mixtures. The first is a moderately rapid reaction, the magnitude of which varies with the composition of the fuel, and is designated here as a precombustion reaction. For most of the fuels in Fig. 1 the precombustion period extends between −10 deg and +15 deg. The second phase is one of very slow liberation of heat or possibly complete absence of exothermic reaction. The third phase is either rapid autoignition or normal combustion initiated by spark ignition at +30 deg. Fuels which autoignited early in the cycle, such as the blend of 40 octane number, showed no second slow reaction period.

The heat-time curve for isooctane up to the point of spark ignition represents an almost exact balance between heat liberated by precombustion reactions and heat lost to the walls. It would thus appear that isooctane reacted slightly under these conditions. But other evidence, not presented in this paper, indicates that isooctane is nonreacting under these engine conditions. The difference shown between isooctane and dib may in large part be due to experimental variation.

Fig. 2 shows the variation of both measured combustion chamber pressure and cumulative heat evolved by the charge (as a function of crank angle) for a 40 octane number primary reference fuel blend with these concentrations of tetraethyl lead: 0, 0.4, 0.7, 1.0, 3.0, and 6.0 ml per gal.

The cumulative heat curves exhibit the same

Why Study Precombustion Reactions?

The study of precombustion reactions is important for two reasons.

The first is the effect which these reactions may have on the knocking process. To date, the exact relationship between precombustion and knock has not been established, but the fact that precombustion alters the chemical nature of the charge indicates that the knocking process can be affected by these early reactions.

The second reason for studying precombustion reactions is that they can have an important effect on the thermal efficiency of the engine cycle. This effect occurs because precombustion reactions are exothermic in nature and occur prior to normal combustion. The result is a change in the rate of heat liberation during the cycle and a consequent change in the thermal efficiency.

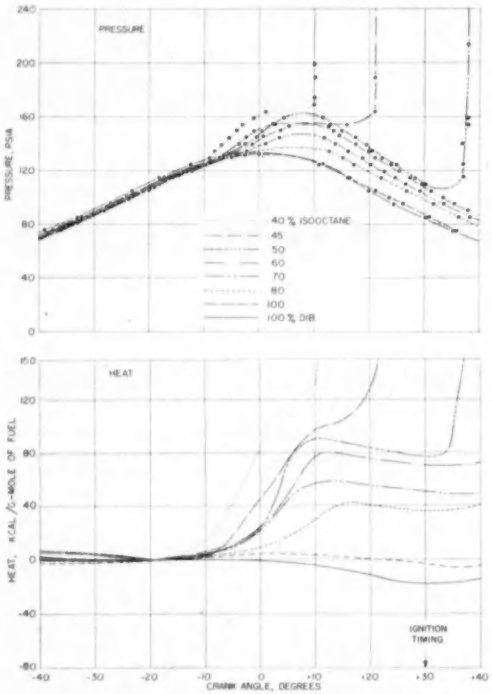


Fig. 1—Combustion chamber pressure and cumulative heat evolved by primary reference fuel blends as a function of crank angle. From the standpoint of heat liberation, there are three distinct phases in the reactions undergone: first a moderately rapid reaction; then very slow liberation of heat (or complete absence of exothermic reaction); and finally either rapid autoignition or normal combustion

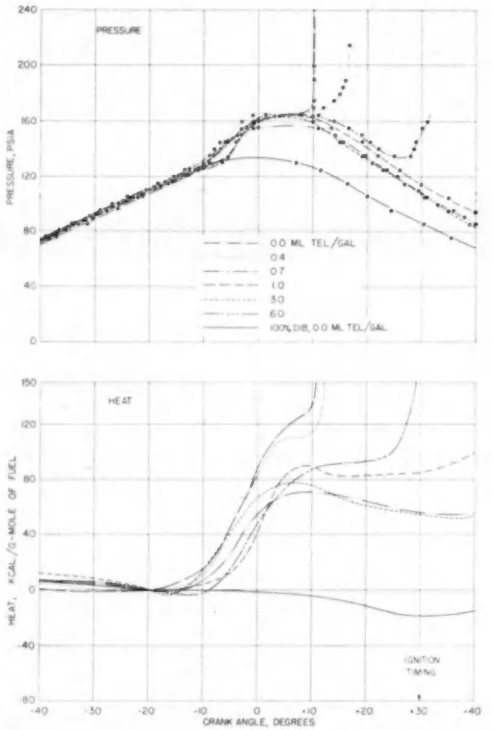


Fig. 2—Precombustion reactions of leaded blends differ from those of unleaded primary reference fuels in that leaded mixtures show nearly equal rates of heat liberation during most of the precombustion period. Tetraethyl lead postpones the onset of autoignition—the higher the concentration, the later autoignition occurs in the cycle, until normal combustion replaces autoignition

three phases as those obtained with the primary reference fuel blends. Precombustion reactions differ from those of the unleaded primary reference fuels in that the leaded mixtures show nearly equal rates of heat liberation during most of the precombustion period irrespective of tel concentration. However, addition of tel is seen to have a very important effect in that it postpones the onset of autoignition. The higher the concentration of tel, the later autoignition occurs in the cycle, until normal combustion replaces autoignition.

A similar plot for a series of blends of dib and *n*-heptane showed a decreasing tendency to autoignite as octane number of the mixture increased. A mixture containing 27% dib exhibited borderline autoignition. Existence of a precombustion period, followed by a delay before the onset of autoignition, was again indicated. But the second stage of the reaction gave indications of being an endothermic process in the case of at least two fuels.

It is interesting to note that the blend containing 50% *n*-heptane in dib was found to be a nonreacting fuel. (The heat-liberation curve was almost identical with that of 100% dib.) This contrasts with the behavior of 50% *n*-heptane in isooctane, which showed large-scale precombustion reactions and autoignition under the same engine conditions.

It is apparent that heats of precombustion can be of considerable magnitude, exceeding in several cases 10% of the total heat of combustion. Fig. 3 shows the relationship between the heat of precombustion and the octane number of the fuel for the three different types of blends tested. It is immediately evident that octane number, per se, is not a measure of heat of precombustion reaction. However, for a given type of blend, an increase in octane number results in a smaller heat of precombustion reaction.

Normal Ignition Tests

Ignition timing for the normal ignition tests was -15 deg, the maximum permissible spark advance without knock for the test fuel—a 60 octane number primary reference fuel blend containing 6 ml tel per gal. Evaluation of the heat evolved by this reacting fuel was made by comparison with isooctane, a nonreacting fuel. Heat of precombustion results are presented in Fig. 4.

Curve A represents the cumulative heat evolved by the fuel-air mixture ahead of the flame front from the time of spark ignition to a point 5 deg before the end of combustion. It is quite evident from the shape of this curve that there are precombustion reactions in the charge ahead of the flame front. This is especially interesting since the engine conditions under which this test was carried out are fairly typical of normal engine operation.

Since the number of moles of fuel ahead of the flame front is constantly changing as the flame progresses across the combustion chamber, the total quantity of heat emitted is not a measure of the intensity of precombustion reaction. Therefore, it is of interest to plot the cumulative heat of precombustion per mole of fuel ahead of the flame front, as in Curve B. A third way of examining these data is given in Curve C, where the time rate of heat liberation is plotted as a function of crank angle.

In interpreting these curves it should be remembered that (1) the heats referred to are those which are evolved by the portion of the fuel-air mixture ahead of the flame front, and (2) the effect of this advancing flame front during the period of combustion is reflected only in its effect on the pressure and temperature of the mixture ahead of the flame front.

The curves show, as in the delayed ignition tests, first a rapid evolution of heat followed by a second phase of much reduced heat development. Autoignition is absent in this case because the mixture ahead of the flame front is completely consumed by the advancing flame before autoignition can occur. Under different engine operating conditions or with a fuel of lesser antiknock value the occurrence of autoignition would be typical of knocking operation in an engine.

The delayed ignition process introduces one basic simplification into the thermodynamic interpretation of precombustion reactions—the fact that there is effectively no change in the number of moles of engine charge during the major part of the process. Naturally, in the analysis of data from engine experiments at normal ignition timings, the number of moles of the mixture ahead of the flame front is constantly changing as the flame front progresses. However, the large changes in the number of moles of the mixture ahead of the flame front occur after the flame has traveled most of the distance across the combustion chamber. Fig. 5 shows how both the volume and number of moles of mixture ahead of the flame front vary with crank angle. Referring back to Fig. 4, which shows the progress of the precombustion during a normal ignition cycle, one can see that most of the precombustion energy is liberated over a relatively short interval of time. This liberation of heat occurs before any appreciable quantity of the charge is consumed by an advancing flame front, that is, before there is any appreciable change in the number of moles of the mixture ahead of the flame.

While the number of moles of mixture ahead of the flame front is not importantly affected by the presence of the flame front for a considerable portion of the time interval during which the flame is traversing the chamber, there is a distinct effect on the volume which this mixture occupies. The

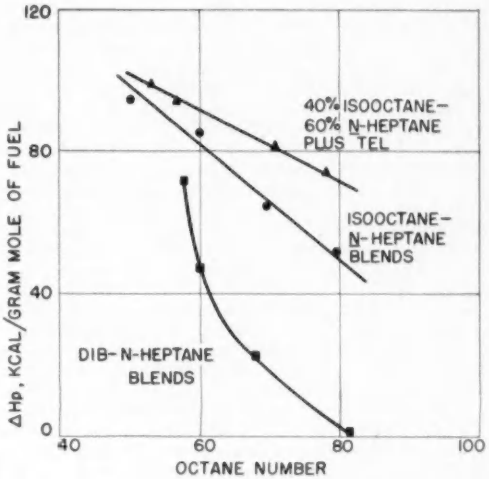


Fig. 3—Octane number, itself, is not a measure of the heat of precombustion reaction. However, for a given type of blend, an increase in octane number results in a smaller heat of precombustion reaction

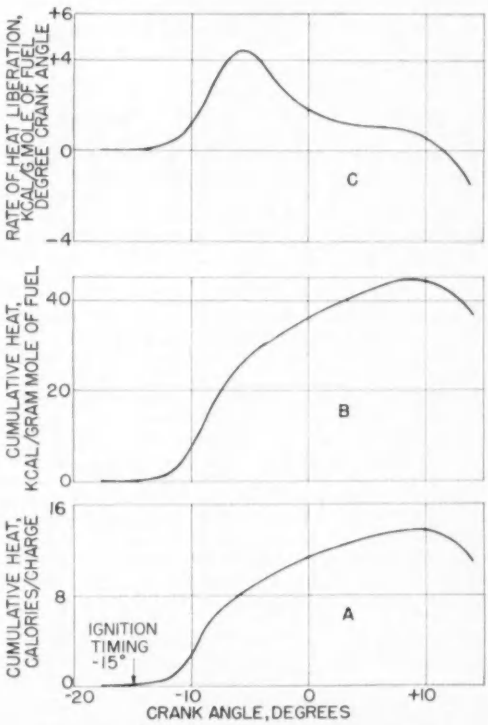


Fig. 4—Three ways to examine the progress of precombustion reaction with normal ignition timing

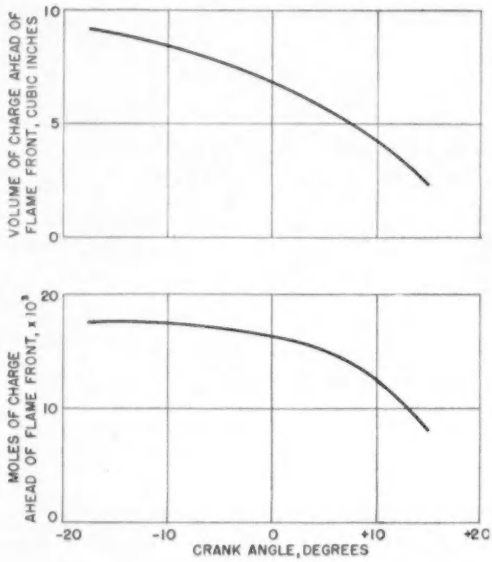


Fig. 5—Large changes in the number of moles of mixture ahead of the flame front occur after the flame has traveled most of the distance across the combustion chamber

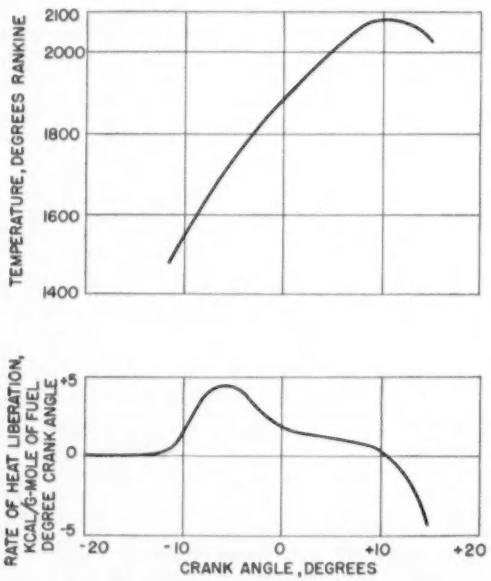


Fig. 6—Effect of temperature on progress of precombustion reaction. The curves indicate that it is necessary to reach a critical temperature to obtain the precombustion reaction, and that subsequent increase in temperature has little effect in increasing the magnitude of this reaction

effect is that of a small amount of fuel-air mixture burning in one end of the combustion chamber and compressing the remaining portion of the mixture ahead of it far out of proportion to the number of moles of fuel which have been consumed. This results in an increase in temperature of the mixture ahead of the flame front over that which it would have if the flame front were not advancing upon it. For this reason there is a distinct difference between the temperature of the mixture during the precombustion reaction period in an engine operated with delayed ignition and in an engine operated with a sufficiently early ignition timing to produce an advancing flame front during the precombustion period. Temperatures are higher for the normal ignition cycle even though the fuel in the delayed ignition cycle is more prereactive.

Despite this fact, evidence obtained in this work

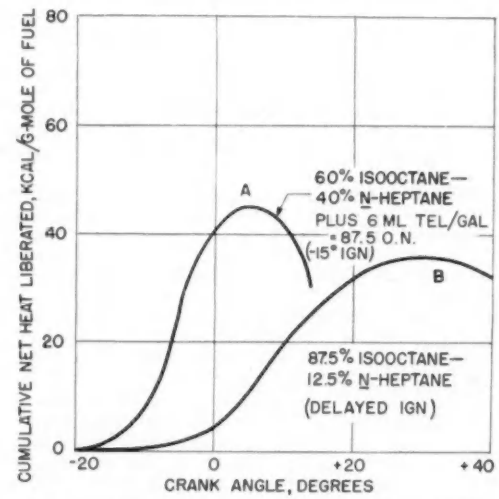


Fig. 7—The rate of heat liberation (due to precombustion reaction) of two fuels of equal octane number varies with ignition timing and fuel lead content

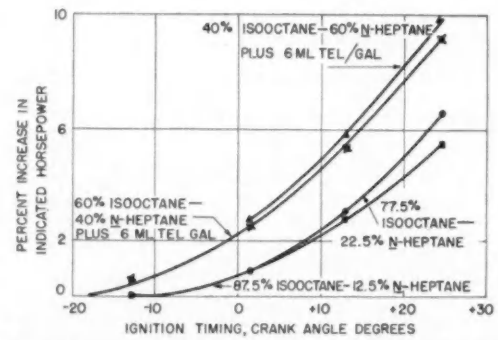


Fig. 8—Percentage increases in indicated horsepower obtained at various ignition timings when reacting fuels were substituted for a nonreacting fuel

shows that the difference in temperature has little effect on the extent of the precombustion reaction. This can be seen in Fig. 6, which shows how the temperature of the mixture ahead of the flame front continually increases with the passage of time up to the point where almost all of the mixture is consumed. While the rate of heat liberation due to precombustion reactions passes through a maximum considerably before the maximum temperature of the mixture is reached, the rate of heat liberation actually decreases for some time and reaches a value of practically zero before the maximum temperature is reached. This implies that to obtain the precombustion reaction, it is necessary to reach a critical temperature, and subsequent increase in temperature (within certain limits) has little effect in enhancing the magnitude of this reaction.

Therefore, the results in terms of heats of precombustion reactions determined in delayed ignition tests are applicable in a quantitative interpretation of precombustion reactions in a normal ignition cycle, if one takes into account the changing number of moles in the charge ahead of the flame front. Furthermore, since the number of moles ahead of the flame is substantially constant over the major portion of the precombustion reaction, it is possible to equate the heats of precombustion calculated from delayed ignition data to the heats which would be obtained from the same fuels under normal ignition timing. Therefore, a convenient method of evaluating the heat of precombustion of a fuel in a normal ignition cycle is to measure the heat of precombustion of the same fuel under delayed ignition conditions.

It would be desirable to be able to compare actual experimental data on the heat of precombustion obtained with a single fuel under delayed and normal ignition timings. Unfortunately, at the present time, such data are not available. However, some supporting evidence for the conclusion reached above is given in Fig. 7.

This figure compares the net heat evolved by the precombustion reaction for two fuels of equal octane number at different ignition timings. The normal ignition test was run with a 60 octane number primary reference fuel blend plus 6 ml tel per gal (Curve A), while the delayed ignition test was run with a nonleaded 87.5 octane number primary reference fuel blend (Curve B). It is seen that the maximum heat of the precombustion reaction is somewhat higher in the case of the leaded fuel. Since the fuels have the same octane number, this difference would have been predicted from Fig. 3. Apparently, then, the change in ignition timing did not importantly affect the total heat of the reaction.

The fact that the leaded blend at normal ignition timing undergoes precombustion earlier in the cycle can be attributed to two factors: (1) difference in the base fuel composition, and (2) change in ignition timing. As previously shown in Fig. 1, the higher concentration of *n*-heptane (which occurs in the leaded fuel) implies a higher initial rate of liberation. Moreover, a change in ignition timing from delayed to normal timing has the effect of increasing the temperature of the unburned charge, so it is reasonable to expect that a fuel would liberate its precombustion heat earlier in the cycle when normally ignited.

Fig. 8 shows the percentage increases in indicated horsepower, obtained at various ignition timings, when reacting fuels were substituted for a nonreacting fuel. Ignition timings of the different reacting fuels were adjusted so that the flame travel after the start of combustion was identical for the reacting and nonreacting fuels. The 40 octane number primary reference fuel blend plus 6 ml tel per gal was equal in antiknock value to the 77.5 primary reference fuel containing no tel. And the 60 primary reference fuel containing 6 ml tel per gal was equal to the 87.5 primary reference fuel containing no tel. From data presented in Figs. 1 and 2, it is apparent that these fuels exhibit precombustion reactions and that isooctane is a nonreacting fuel under this operating procedure.

Outstanding feature of Fig. 8 is that it shows that the percentage increases in indicated horsepower are considerably magnified as the spark is retarded. Furthermore, the increases are appreciably larger for a fuel containing tel than for a nonleaded fuel of equal octane number.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Excerpts from Discussion by

E. S. Corner

Standard Oil Development Co.

ONE of the most important contributions that prereaction studies can make to an understanding of oxidation reactions taking place in an internal combustion engine is that of the role of tetraethyl lead and other antiknock agents in suppressing engine knock.

It has been shown by the Development Company that the tel was completely destroyed in combination with *n*-heptane under conditions where it was only 50% destroyed when added to toluene. These data indicate that some tel reacts directly with intermediates (radicals or oxygenated compounds) formed by prereacting compounds and thereby probably controls chain-branching reactions which eventually lead to knock. This may explain the apparent relationship between the extent of prereactions in the absence of tel and the improvement in antiknock quality by tel addition. In addition, this mechanism would explain the fact that tel has a relatively small effect on the temperature at which prereactions are initiated. In the actual combustion flame, oxides of lead may be compounds tending to suppress knock.

A large amount of research will unquestionably be required before the nature of prereactions and associated combustion phenomena is known with certainty. In the meantime, however, it is gratifying—from a practical viewpoint—to know that the existence of prereactions does not adversely affect the power output of an internal combustion engine.

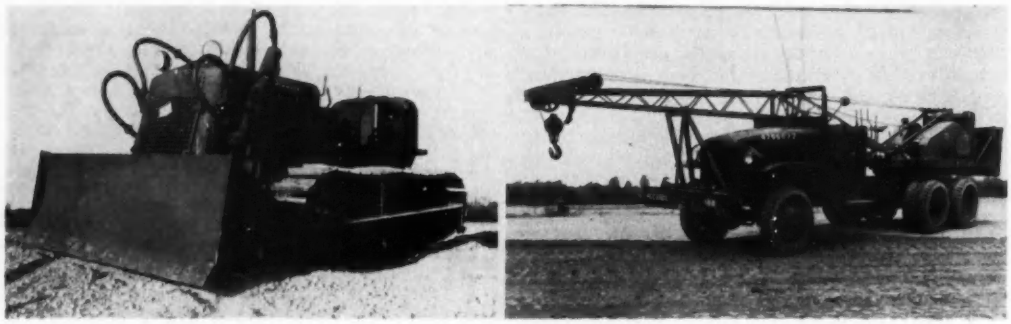


Fig. 1—Typical of the lightweight, highly-productive earthmoving equipment used in military airborne operations are the special 16,000 lb crawler tractor and the 16,000 lb truck-mounted crane

"Military Specials" Not Desired by Military

Based on paper by

JOHN A. CALDWELL Chief, Mechanical Equipment Branch, ERGDL, Fort Belvoir, Va.

THE Corps of Engineers does not want "Military Specials." They are expensive, troublesome, time consuming to develop, and create production problems in wartime when required in quantity. However, most commercial vehicles have to be modified in some way because of the very nature of military operations.

Suitable for Military Transport

One of the primary reasons for modifying standard items of equipment is to make them suitable for military transport. Equipment must be transportable with least expense and effort, and it must arrive at its destinations in good order. This dictates relatively lightweight, high performance items—equipped so that they can be loaded, lashed down, and unloaded readily.

Those items which must be transported overseas must be processed and packaged for protective purposes. All of the units, of course, must meet the weight and dimensional limitations of the transporters. Most commercial items meet railroad limitations in this respect. However, the limitations in weight, height, width and length imposed by landing vessels and cargo aircraft are more restrictive. Equipment transported by either method should be capable of being loaded or unloaded under its own power and of being backed in readily so that it may be driven out when landing.

Other factors which must be considered in transport by air—and which sometimes occasion modifications—are the abilities of components and attachments to withstand impact, effects of change in altitude, and in some cases crash landings.

Meet Special Tactical Requirements

Another major reason for modifying standard equipment is to meet special military tactical requirements.

Radio suppression of all motorized items is necessary: (1) to prevent interference with our own radio and radar equipment, and (2) to keep the enemy from locating our equipment by radio detection.

Better lighting equipment than that provided by commercial practice is required. Almost the same efficiency can be obtained in night work operations as in daylight if adequate lighting is provided. Sufficient lighting is required to provide the operator with good vision forward, on the ends of his cutting blade, and to the rear when backing up.

The ever-increasing popularity of air transport in military operations dictates that earthmoving equipment be capable of being air transportable. While some of it may be disassembled for this purpose, it is highly desirable that each piece be transportable as a unit to save both time and manpower since airborne operations are more urgent and have to meet more critical schedules than other operations.

Lightweight, highly-productive earthmoving equipment which can be put into use within a matter of a few minutes after it is landed must be used in many military airborne operations. This equipment paves the way for progressively larger items which are flown in during later phases as more adequate landing facilities are provided and more time is available to prepare them for use. A good example of an item of equipment which has been modified to meet the requirements for use in the early phases of such an airborne operation is the 16,000 lb special airborne crawler tractor. Another modified commercial item for airborne use is the 16,000 lb truck-mounted crane. (See Fig. 1.)

Atomic warfare also presents its problems. Equipment for digging personnel trenches rapidly for hospital and other personnel who are not able to dig their own is under development. High speed tunelling machines for underground construction work and equipment for clearing passages through radioactive areas are indicated. All of these are items for which modified commercial units may provide solutions.

Use Under Extreme Environmental Conditions

Another primary reason for modifying commercial earthmoving equipment is to make it suitable for military use under the extreme environmental conditions found in various areas of the world. For use in the tropics, standard items must be treated to protect them from fungi which ordinarily attack and destroy such components as wiring, belting, and so forth, in a very short time. Also, since marshy conditions predominate in such areas, all vehicles need to have very good flotation characteristics.

Similarly, operation in the Arctic presents its special problems. With temperatures as low as -65 F in the winter, starting and operating are difficult. Ordinary lubricants and diesel fuels congeal and even gasoline does not vaporize as readily as it should. Standard batteries lose their

life and the stamina of operators and maintenance personnel are highly reduced. Movement over the frozen terrain is like going over rocks, and the equipment and its riders are subjected to tremendous abuse.

Equipment must be capable, therefore, of being easily started in a reasonable period of time. It must be lubricated with special lubricants and provided with special fuel. It must be equipped with winterization kits which include heating and insulating equipment for the engines, batteries and tractor cabs or canvas enclosures. Since personnel must wear heavy clothing—mittens and boots—controls must be widely spaced and items requiring frequent adjustment must be readily accessible. Some method of cushioning both the tractor and the operator from the shocks of travel is highly desirable.

Ease of Operation and Maintenance

Always of concern to the Army is the maintenance of its equipment. It must be easy to operate, capable of withstanding a high degree of abuse, and require as little maintenance as possible. High mortality parts should be readily accessible and easily replaced and lubricating fittings should be easy to locate and to service. Only standard Army lubricants should be required.

Coupled with maintenance is a definite need for interchangeability of parts and assemblies among various items of equipment. Under the best of circumstances, the general parts supply of the Corps of Engineers is highly complicated. Spare parts must be procured and supplied to the field for many hundreds of items of equipment. Any practical standardization and interchangeability of parts which can be effected will contribute toward simplification of the supply picture and aid in keeping the equipment in the field in running condition. (Paper, "Modification of Standard Earthmoving Equipment for Military Requirements," was presented at SAE National Tractor Meeting, Milwaukee, Sept. 11, 1951. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Urges Saner Laws To Aid Transportation

Based on paper by

ARTHUR C. BUTLER

National Highway Users Conference, Inc.

HIGHWAY transportation law can be a driving force in eliminating critical deficiencies in our highway system, and it can write the ticket for sound programming in the future. But there are other changes in the law needed to improve conditions in highway transportation, notably in ton-mile legislation and in laws regulating sizes and weights.

The ton-mile theory has attracted popularity because of its deceiving simplicity and the relative ease of obtaining approximating data and making calculations. A number of states have enacted ton-mile laws but in almost all cases they mave had difficulty in adapting theory to an enforceable and administratively feasible tax.

The dilemma confronting ton-mile proponents was concisely summed up in testimony before the Ohio House Commerce and Transportation Committee by former Tax Commissioner C. Emory Glanders when he said: "If you make the tax practical to collect, it will be inequitable; if you make it equitable, it will be impractical."

New York's recent adoption of a ton-mile tax has been resented by neighboring states. Vermont has enacted retaliatory legislation and other states are considering it. Such relations constitute a backward step; therefore, laws of this kind should be repealed.

Perhaps the most important and certainly most controversial example of the conflict between the dynamic technology of the motor vehicle and the stabilizing effect of the law is in the regulation of sizes and weights. Virtually every state legislature at each session has acted upon some phase of this difficult problem, but on the whole it is now being handled with more intelligence and reasonableness.

The railroads, which took an active part in the promotion of restrictive laws, are now pinpointing their attack against the for-hire truckers, thus affecting all trucks. If they succeed in dividing and conquering they may gain sufficient courage to tackle the private automobile, their chief competitor. They have succeeded in creating some bad feeling between bus and truck operators on the one hand and the passenger car owner on the other; they are making headway with public opinion, particularly as it relates to trucks. In this they are aided by that small segment of operators who are violating the loading laws and are making themselves unpopular by unpardonable practices. The vast majority who do obey the law should aid in cleaning out these violators lest the many suffer with the few from retaliatory laws.

We must put our house in order. The willful violation of state laws cannot be tolerated. Even if there is an honest belief that any given limit is discriminatory and unsound, violation is not the way to remedy the situation.

Furthermore, operators and highway officials will have to abandon some of their intransigent stands. The east and west should not be fighting over sizes and weights. They have different problems which may require regional solutions. It may be that national uniformity is impossible in this field for some time to come, but progress can be made through a cooperative approach by men who are sincere and of good will. (Paper, "The Highway User Faces the Law," was presented at SAE National Transportation Meeting, Chicago, Oct. 29, 1951. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

"The law on most phases of motor vehicle equipment has been most prone to recognize engineering improvements in vehicles.

"While SAE does not deal in legislation, the findings of its technical committees have, at long range, had a profound effect on law and regulatory changes on the basis of newer, safer, and more efficient motor vehicles.

"Engineering views in this field have been most helpful from time to time in breaking highway trade barriers between the states."

—Arthur C. Butler, Director
National Highway Users Conference, Inc.

Turbocharging of High Speed Diesels Studied

Excerpts from paper by

N. M. REINERS
W. D. SCHWAB
Cummins Engine Co., Inc.

WHILE much more development is required to obtain a complete picture, initial investigation has highlighted the advantages, disadvantages, and possibilities of turbosupercharging high speed diesel engines.

Use of a turbosupercharger increased the maximum horsepower output of the Cummins NHRS engine 70% over the naturally aspirated rating and 13% over the Roots-charged rating. And increased power output was accomplished with the same maximum fuel rate as used for the Roots-charged engine. (See Fig. 1.)

Full load performance characteristics of the turbosupercharged engine at low engine speeds were not as satisfactory as those of the Roots-charged engine. Power fell off and fuel consumption increased on the turbosupercharged engine as engine speed was decreased, until at 1200 rpm the performance was approximately 10% below that of the Roots-charged engine. This condition resulted in a continually falling torque curve as speed was reduced—a condition unfavorable for automotive applications.

Increasing intake air temperature can seriously decrease the maximum power output of a turbosupercharged engine if this necessitates reducing the fuel rate to avoid exceeding maximum exhaust temperatures allowed by the turbosupercharger or the engine. Without exhaust temperature limitations, the rate of decrease in power—with an increase in intake air temperature—was approximately the same as for the Roots-charged engine (1% per 10 F increase).

Although effect of altitude was not determined, it is apparent that turbosupercharger operating limits would have considerable influence on the effect of altitude performance. If operational limits of rotor speed and exhaust temperature could be neglected, sea level engine power could conceivably be maintained at any altitude. However, since the limitations are approached at approximately sea level, such benefits may not be realized.

As a result of limited rate of acceleration of the turbosupercharger, the required air-fuel ratio for commercially acceptable exhaust smoke cannot be obtained on the turbosupercharged engine under all dynamic operating conditions.

Some of the adverse characteristics found during this initial development work may be solved by such simple methods as better matching of the turbosupercharger to the engine. Other adverse conditions, however, may require considerable development to make the turbosupercharged diesel engine as versatile as the present diesel engine supercharged with the Roots type blower.

Development of the turbosupercharged engine is being energetically continued. Efforts are being made to employ the benefits of turbosupercharging to the fullest possible extent wherever possible. Moreover, development will be carried to the point where no compromise in engine performance characteristics, serviceability, or dependability is required in enjoying these benefits. (Paper, "Turbosupercharging of High Speed Diesel Engines," was presented at the SAE National West Coast Meeting, Seattle, on Aug. 13, 1951. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

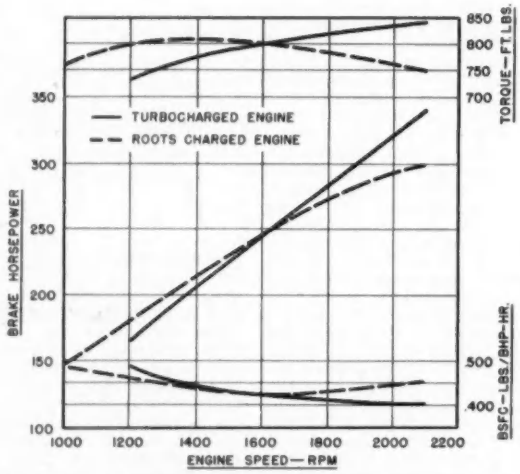


Fig. 1—Use of a turbosupercharger increased the maximum horsepower output of the Cummins NHRS engine 13% over the Roots-charged rating. Increased power output was accomplished with the same maximum fuel rate as used for the Roots-charged engine

Fatigue Life Of Gears Estimated

Based on paper by

WELLS COLEMAN
Gleason Works

(This paper will be printed in full in SAE Quarterly Transactions)

TO overcome some of the deficiencies in previous methods of determining the fatigue life of bevel and hypoid gears, a new method has been developed which differs from the old in the following ways:

1. The tooth strength is considered in the normal section rather than in the transverse section.
2. The position of the point of load application is determined by taking into account not only the theoretical lines of contact but also "mismatch" and certain experimental evidence.
3. The load carried by one tooth is estimated in a rational manner based on "mismatched" and contact ratio.
4. The radial component of the normal load is considered.
5. A stress concentration factor based on experimental data is applied.
6. The concept of "effective face width" is introduced.
7. A size factor is introduced, based on experimental evidence that allowable stress varies with size of tooth.
8. A mounting factor which allows for the deflection of the gear mounting is included.
9. The velocity factor is replaced by two impact factors—an inertia factor and a temperature factor.

(Paper, "An Improved Method for Estimating the Fatigue Life of Bevel Gears and Hypoid Gears," was presented at SAE Summer Meeting, French Lick, Ind., June 3, 1951. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

TECHNICAL COMMITTEE *Progress*

New Chairman and Six New Members Take Office on '52 SAE Technical Board

GEORGE A. DELANEY has been named chairman of the SAE Technical Board for 1952. He is chief engineer of GMC's Pontiac Motor Division and has been chairman of the Meetings Committee and an SAE vice-president as well as a Technical Board member.

Six new members were also appointed by SAE President D. P. Barnard to terms expiring at the end of the 1954 administrative year. They are P. C. Ackerman; L. R. Buckendale; E. S. MacPherson; A. F. Meyer, Jr.; F. N. Piasecki; and W. M. Walworth.

These new members attended the Board's meeting last month during the SAE Annual Meeting in Detroit.

Board members who continue in office are B. B. Bachman, R. D. Kelly, R. P. Kroon, R. P. Lansing, R. P. Lewis, W. G. Lundquist, M. E. Nuttila, R. J. S. Pigott, S. W. Sparrow, F. W. Tanquary, and W. H. Worthington.

Members whose terms expired at the end of the 1951 administrative year were Harry Bernard, G. W. Brady, A. T. Colwell, C. T. Doman, A. G. Herreshoff, H. L. Rittenhouse, R. R. Teetor, and H. T. Youngren.

1952 SAE Technical Board

G. A. Delaney, Chairman

P. C. Ackerman	R. P. Lewis	F. N. Piasecki
B. B. Bachman	W. G. Lundquist	R. J. S. Pigott
L. R. Buckendale	E. S. MacPherson	S. W. Sparrow
R. D. Kelly	A. F. Meyer, Jr.	F. W. Tanquary
R. P. Kroon	M. E. Nuttila	W. M. Walworth
R. P. Lansing		W. H. Worthington

New Board Chairman

GEORGE DELANEY, chief engineer of Pontiac, is the 1952 chairman of the SAE Technical Board

CRC Publishes Report "Road Rating Techniques"

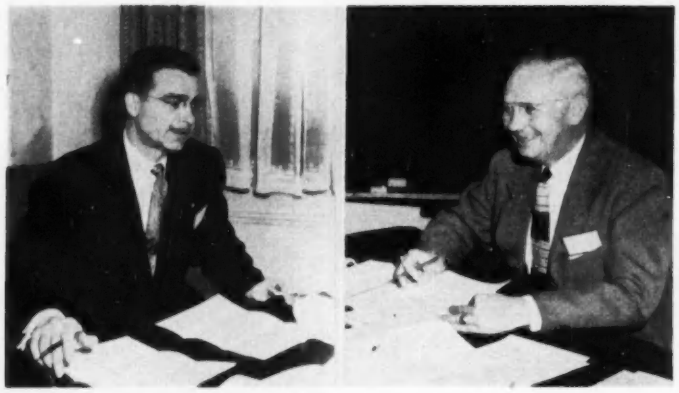
THREE research techniques for evaluating antiknock qualities of fuels in vehicles on the road are outlined in "Road Rating Techniques," recently released by the Coordinating Research Council. The Road Test Group working on detonation projects of the Motor Fuels Division prepared the report.

The three test techniques are

1. Modified Uniontown (CRC Designation F-28)
2. Standard Borderline (CRC Designation F-26)
3. Modified Borderline (CRC Designation F-27)

The Modified Uniontown Test Technique rates fuels at full throttle at a single speed which is the speed at which the fuel is most prone to knock. The technique was designed to rate

New and Retiring Aeronautics Committee Chairmen



WILLIAM C. LAWRENCE (left), director of engineering, American Airlines, has been named chairman of the SAE Aeronautics Committee. Retiring chairman, RAYMOND D. KELLY (right) is superintendent of technical development, United Airlines

fuels in the same manner as the motoring public would evaluate the fuels under severe operating conditions. For this reason it is valuable in rating finished commercial gasoline.

This Modified Uniontown Technique evaluates the fuels in terms of primary reference fuels. The octane number assigned to a test fuel corresponds to the matching blend of primary reference fuels that will produce the same trace knock as the test fuel at the same ignition timing. The basic distributor spark advance is varied until trace knock is obtained for both test and reference fuels regardless of the speed of maximum knock. A standard distributor is used, and the observer records the spark advance required for trace knock and the speed at which the knock occurs.

The difference between the Modified Uniontown Procedure and the Uniontown Procedure is that for the former, knock intensity is kept constant while spark advance and speed are varied, and for the latter, spark advance is kept constant while knock intensity and speed are varied.

The Borderline Test Technique rates fuels at full throttle throughout the engine speed range rather than at a single speed. For this reason it is valuable for (1) research work on experimental fuels and components; (2) determination of the adequacy or inadequacy of a fuel to satisfy the engine at any given speed, thereby being useful in developing distributor curves to fit the fuels; and (3) comparison of one fuel with another at any engine speed.

This technique requires a "fixed" distributor (all automatic advance mechanisms rendered inoperative). The knock-die-out speed of the fuel is obtained with successively increased spark advances. Thus a curve of knock-die-out speed versus spark advance is obtained for each fuel.

The Modified Borderline Research Technique may be used for the same general purposes as the Borderline Technique, but all data are recorded at trace knock intensity. The technique provides a means of controlling knock level at wide-open throttle through the speed range, and thus makes it possible for the operator to determine at any instant whether or not autoignition is incipient.

All three techniques have been in use for some time, but this report contains the first detailed description published by CRC. For each technique, test preparations, procedure, and form of report are specified.

The report, CRC-259, has thirty-two $8\frac{1}{2} \times 11$-in. pages. It is available at $2.00 to SAE members and $4.00 to nonmembers from the SAE Special Publications Department, 29 West 39th St., New York 18, N. Y.

John R. Dziel, Fairchild Engine Division, is chairman of the subcommittee of Aeronautical Committee S-1 that developed the standard on turbine engine blade dimensioning

ARP on Turbine Blade Dimensioning

AERONAUTICAL Recommended Practice (ARP-265) entitled "Blade or Vane—Dimensioning of Turbine Engine Airfoil" developed by a subcommittee of SAE Committee S-1 (Aeronautical Drafting Manual), has been approved by the Technical Board. This ARP was requested by the Aircraft Industries Association as the result of an industry meeting on proposed projects for the development of manufacturing methods and processes. At this meeting it was requested that jet engine manufacturers standardize their method of dimensioning blade shapes — before high-production inspection equipment for blades be developed.

This ARP provides a standard method of dimensioning turbine engine airfoil blades or vanes. Its purpose is to effect a common method of describing and controlling blade or vane elements, so as to aid in the standardization of manufacturing and inspection practices in the aircraft turbine engine industry.

A meeting with blade suppliers, prior to undertaking the actual development of the standard, allowed the subcommittee to ascertain the problems of the suppliers in interpreting the drawings produced by the various engine manufacturers. By holding meetings every month, the subcommittee was able to develop the ARP in a little over a year.

It reflects a unanimity of agreement by this subcommittee of aircraft turbine engine specialists and clearly defines the design manufacturer's requirements for a satisfactory product.

The ARP was coordinated with the Engine, Propeller, Accessories, and Equipment and the Special Aircraft Projects Divisions. It has been approved by the Aeronautics Committee and the Technical Board.

Members of the subcommittee are: John R. Dziel, Fairchild Engine Division, chairman; R. W. Henry, Pratt & Whitney Aircraft; P. V. Richards, Wright Aeronautical Division; L. R. Smith, Allison Division, GMC; E. W. Egee, Westinghouse Electric Co.; and E. R. Fairbanks, General Electric Co.

1952 SAE Annual Meeting

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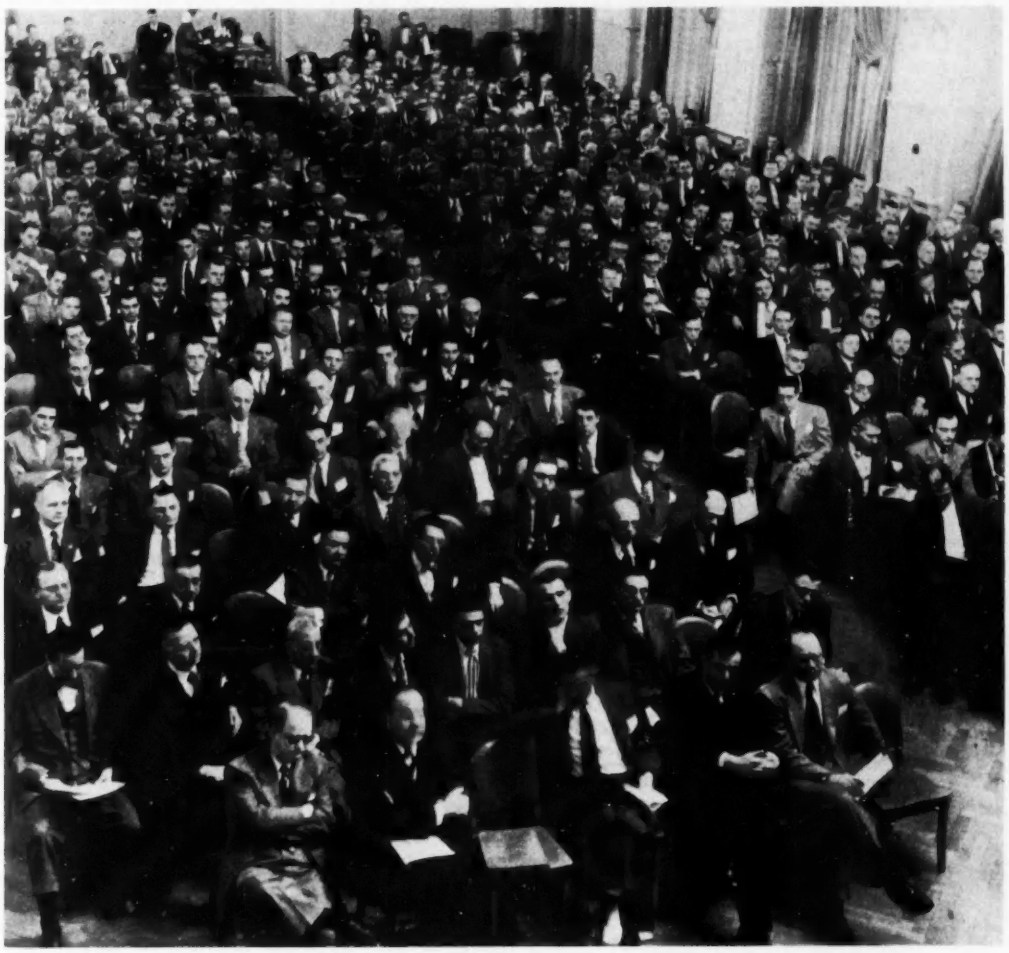


of songs from Broadway hits by the Ford Motor Co. Chorus. Under the direction of Ray C. Kooi, this large chorus of mixed voices delighted the entire audience of engineers.

McFarland Paints Progress from 4 Buckets

"If you want a white house," McFarland told the nearly 3000 gathered at the dinner, "you paint the house with white paint . . . and sometime later, you must paint it again and again. The big trouble with successful people and companies is that they will quit doing the things and following the policies which made them successful . . ."

Then the noted educator, who now is a consultant to General Motors Corp., gave his listeners four buckets of paint with which to keep their houses white:

(1) *Too many people quit looking for work after they find a job.* . . . We have had two abnormal

Around the Meeting . . .

Acute shortage of copper will continue well into 1953, Munitions Board's Major-Gen. F. H. Griswold predicted Tuesday evening. Other predictions—assuming no more war than now—included:

Strictly military requirements will take about 18% of our gross national product in 1952—as against 12% last year . . . and, at peak of consumption, about 11% of our total supply of carbon steel.

But for every ton going direct to munitions another 1/3 ton will go for other products the military will use. The combination of the two will level off with 40% of the alloy steel; 20% of the structural steel; 32% of our copper; and 50% of aluminum.

Should be some easing of aluminum in 1953; of steel perhaps late in 1952.

* * * *

Bad flying weather made a few Annual Meeting participants late in arriving for pre-meeting conferences on Sunday or opening day activities. . . . But good weather prevailed during most of the week.

* * * *

Photographs around the meeting in this issue are by Eleanor Allen, SAE Journal technical editor. Scheduled for later issues are pics of more committeemen at work—and a phototale of "Backstage at a big SAE Dinner."

* * * *

The 1952 Annual Meeting was the first to be held at the Sheraton-Cadillac Hotel in Detroit. Long the site of SAE Annual Meetings, the Book-Cadillac became a part of the Sheraton chain last November—and had its name changed to Sheraton-Cadillac early in December . . . but the big sign "Book-Cadillac" over the front door still remains to be replaced.

decades so far as training workers is concerned. There were no jobs for youth in the 1930's—and too many jobs in the 1940's. We must teach youth all over again such fundamental concepts as that each person's success is bound up with that of the whole business. The strength of the wolf is the strength of the pack—and the strength of the pack is the strength of the wolf.

(2) *When you pitch the hot potatoes to somebody else you usually lose the gravy too. . . .* Those who would rise in professional or business stature must learn to take hold of both the clean and the dirty ends of the stick.

(3) *Always look for reasons why you can do things—rather than for reasons why you can't. . . .* This viewpoint alone can spell the difference between success and failure for both individuals and institutions.

(4) *There is no market for cynics.* If we lose faith in the fundamental goodness of mankind, we lose the mainspring of man's ability to serve his fellow men successfully.

By keeping the basic principles of organization bright, McFarland concluded, we can build a house on a hill—and we shall not have to wait until the storm is over before we can be sure it will stand.

Engineering Joys and Sorrows Barnard Topic

Automotive Engineers can agree with Ex-President Herbert Hoover that "As a profession, engineering has both joys and sorrows," Barnard said in a brief inaugural address at the dinner.

At least a few of the idiosyncrasies of the automobile engineer's product are the fault of the customers, Barnard said . . . customers who insist on chromium on the bumpers, where it doesn't belong, instead of on the piston rings, where—as one SAE member has pointed out—it ought to be.

Citing a few "worries" of the fuels and lubricants engineers, Barnard said: "An oil which just quietly lubricates is no more acceptable—or salable—than a cereal that just lies still and tastes good. Federal and state taxes on a gallon of gasoline are greater than either raw material costs or the expense of manufacturing operations. We sometimes wonder whether we are in the fuel business or whether we are a tax collecting agency."

The members of the SAE, he concluded, can be counted on "to face their increasing burdens with a smile—even if a wry one—and to keep on evolving the best possible results with inadequate supplies."

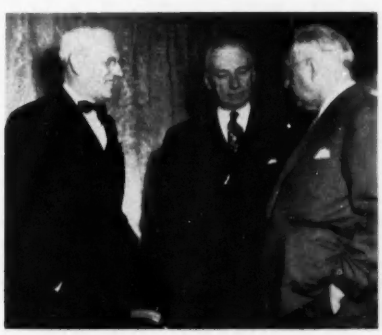
Roeder Stresses Advances in 1951

Saying "It's my job to tell you about the road we've traveled in the past year," Roeder told of many improved services to SAE members. He attributed them to "the thoughtful action of our more than 3500 committeemen and officers." Among the many 1951 advances he mentioned were establishment of eight new student branches, a new high of 15,400 dues paying members, total attendance at

At the Dinner Reception . . . .

DR. KENNETH McFARLAND (right) was the main speaker at the dinner; Elmer A. Clark (center) was master of ceremonies; and Detroit Section Chairman W. H. Graves opened the dinner proceedings with a welcome to the members and guests

Below, left: Joseph K. Roberts, general manager, research and development, Standard Oil Co. (Indiana) . . . . Center: SAE Past-President L. Ray Buckendale, vice-president in charge of engineering for Timken-Detroit Axle Co., with A. G. Herreshoff, Chrysler Corp.'s chief engineer for development design, and H. T. Youngren, vice-president of engineering for Ford Motor Co. . . . . Right: Past-President Arthur Nutt with William Cronin, general manager of the Automobile Manufacturers Association, and Allen B. Crow, president of the Economic Club of Detroit



National meetings alone of more than 12,000. Six of these National meetings, he noted, were the largest ever held—and the total of technical papers presented was some 15% higher than in 1950.

"All in all," he concluded, "our Society has never been in better shape than it is today. SAE is well prepared to discharge its traditional duties and to shoulder whatever new responsibilities it may be asked to assume."

Special events during the meeting included presentation of the 1950 Horning Memorial Award to D. L. Pastell for the best paper presented before SAE in that year on fuel-engine relationships. The presentation was made in person by Mrs. H. L. Horning with the cooperation of Horning Memorial Board of Award Chairman G. C. Wilson. The paper for which Pastell received the award was titled "Precombustion Reactions in a Motored Engine." Pictures of the presentation event will be ready for the March SAE Journal.

Of broad interest to all engineers involved in presenting papers and engineering reports was a paper titled "Make Slides Worth While" by B. A. Jones of Ethyl Corp. In it, he detailed successful, practical methods of preparing and presenting illustrative material in slides for engineering papers.

AERONAUTIC Engineers Contrast Design Philosophies

ENGINEERS at the sessions of SAE's three aeronautic activities considered contrasting design philosophies in such varied fields as computing machines, aircraft auxiliary drives, guided missiles, and passenger and cargo protection. Their aim was, in most cases, to define the usefulness of each philosophy or to seek the best compromise or combination. And, in most cases, they succeeded.

The symposium on modern computing machines weighed the advantages of digital computers against electronic analogs in analyzing engine and propeller designs. Karl E. Fransson told how Pratt and Whitney performed a vibration analysis of an engine design using an International Business Machines digital computer. It took four months altogether—one month to determine probable orders of precision, one and a half months to assemble engine mass and stiffness constants, one month to set up the differential equations, and three weeks of machine time.

For the sake of comparison, P&WA submitted the problem to California Institute of Technology for solution on their very accurate analog. There setup time was approximately three days and calculation time was "one Saturday afternoon."

The answers checked closely with each other and with test data obtained later, Fransson said.

J. T. Horner reported that Allison is finding digital computers useful for (1) generalized design studies, (2) detail design of components, and (3) fundamental research such as boundary-layer studies and flutter analysis. F. B. Stulen and J. A. DeVries added that Curtiss-Wright is using digital computers to study aerodynamically excited vibration of propeller blades. W. C. Schaffer described Wright Aeronautical's success with analogs in solving control problems of jet engines.

All emphasized that computing machines are making it possible for engineers to solve problems too expensive in time and money to solve experimentally or by conventional calculation methods.

The consensus seemed to be that both digital computers and analogs have their places. Digital equipment is inherently accurate. . . . Analogs take little set-up and calculational time. Choice between the two types depends on whether the problems to be solved require very accurate solutions—and, if so, whether the time element justifies the expense of assembling a sufficiently accurate analog.

The symposium on computing machines, for which G. W. Newton was chairman, was one of two sessions sponsored by the Aircraft Powerplant Activity. At the other session, for which R. W. Rummel was chairman:

• V. E. Yust of Shell Oil and E. A. Droegemueller of Pratt and Whitney Aircraft announced success of tricresyl phosphate as a lead scavenger to alleviate aviation spark plug fouling. The phosphate compound is used in place of some of the customary ethylene dibromide in the aviation ethyl fluid. With the combination of scavengers, deposition of metallic lead is minimized, lead salts formed are those of low electrical conductivity, deposits slough off readily, and little free-carbon deposit forms. The 4000 hours of flight testing completed show a definite reduction in plug fouling.

In discussion following the Yust-Droegemueller paper, W. C. Lawrence reported that American Airlines is flight-testing tricresyl phosphate in the right-side engines of two DC-6's. During the 500 or 550 flight-hr already flown, no deleterious effects attributable to the new scavenging agent have appeared. Neither has there been any unscheduled change of spark plugs, so confirmation of anti-foul-

Continued on Page 66

• • • • Interviews

Newspaper and business paper interest in the sessions and personalities was high. Special interviews each day brought many questions, interesting answers—and subsequent quotations in print.

1952 SAE Technical Board Chairman George Delaney was the first to meet the press. Next came SAE's 1952 President Dr. D. P. Barnard. Then later in the week, W. K. Creson on power steering; Jerome Lederer and Lt.-Col. George Hewitt on "packaging passengers;" Past-Presidents R. J. S. Pigott and A. T. Colwell on a high-jet system for increasing tool life; 1952 SAE Vice-President D. Roy Shoults on missile production and testing; and A. H. Hobelmann and S. Huey on high pressure pneumatics in modern fighter aircraft.

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1. Dr. D. P. Barnard talks with reporters following announcement of his election as 1952 SAE President.

2. The press gallery at one of the interviews. More than 40 newspapers and business papers had representatives at the meeting.

3. SAE Technical Board Chairman George A. Delaney was the first to "meet the press."

Sparrow Receives Life Membership

SAE Past-President S. W. Sparrow (right) receives a life membership. Presentation was made by 1951 SAE President Dale Roeder at the Annual Business Session of the Society on Tuesday, January 15

ing properties must await accumulation of additional flight-hours.

If the decision is made to use the new scavenger, we believe it should go into all aviation fuel, said C. R. Johnson of Shell Oil. How soon it goes into the fuel depends on when operators and the military services decide there are enough data to justify the additive's adoption. Then the tricresyl phosphate will be added to the fuel via the ethyl fluid, and the cost will be only a small fraction of a cent per gallon of fuel, Johnson predicted.

• R. E. Gorton and B. E. Miller, two more Pratt and Whitney Aircraft men, described—among other instruments for gas turbine development—a photoelectric radiation detector for burner studies. This contains a quartz lens which may be aimed through a window in the burner wall on a nonradiating pocket in the far burner wall. The optical system focuses any radiation within a narrow field of view upon a multiplier phototube. The phototube output, a measure of the radiation present in the field of view, is presented on a remote meter. This indicates relative flame intensity. Between the lens and the phototube is also a remotely controlled positioning device carrying two optical filters. Each removes ultraviolet radiation below its selected cut-off wavelength. By reading the output with both filters interposed, then with one, and with no filter, a sort of color analysis of the flame results. The filter cut-off wavelengths are chosen to permit determining presence or absence of some of the more important chemical radicals occurring in hydrocarbon combustion.

"Multiple-Shielded High Temperature Probes—Comparison of Experimental and Calculated Errors" by E. M. Moffatt, Airflo Instrument Co., was presented by title at this Aircraft Powerplant session also.

In one of two sessions sponsored by the Aircraft Activity, proponents of pneumatic and those of hydraulic systems for powering accessories had a hearing.

It was Homer J. Wood's contention that pneumatic turbine drives, particularly bleed-and-burn drives, are competitive with all other known forms of auxiliary drives for turbine-propelled aircraft. Wood is with AiResearch. He felt that pneumatic power is especially favorable at altitudes below 50,000 ft and flight durations of a few hours or less.

Other speakers indicated that both pneumatic and hydraulic drive systems will be used for some time. The Kidde pneumatic B-1 automatic gun charger is already being tested in F-84's, A. H. Hobelman of Kidde and S. Huey of Republic Aviation related. And they considered it a certainty that pneumatic systems will be used to a greater extent in the near future to do such jobs as start engines, launch rockets, and extend and retract landing gear.

Hydraulic systems are now driving, among other things, radar scanners, turrets, winches, generators, alternators, and fuel-transfer pumps, Vickers' K. I. Postel and R. A. Meade noted. Drive requirements of the near future call for hydraulic transmissions delivering 100 hp, they said.

Session Chairman F. O. Hosterman announced two papers presented by title at this Aircraft Activity session. They were "A System of Reducing Flight Test Data to Standard Conditions Applicable to All Subsonic Speeds and Large Angles of Climb and Glide," by C. N. Sanford of Iowa State College and "Some Effects of Vibration Within Electron Tubes" by R. H. McNary of Boeing Airplane Co.

The other Aircraft Activity session was a symposium on missile production and testing problems with D. R. Shoults as chairman. Experts weighed the philosophies of design of missile components for short life and design for reliability and came out in favor of utmost reliability. In fact, they showed that components need considerable life just to endure the testing needed to insure their reliability.

Even 99% reliability is not adequate for missile components, Bell Aircraft's Jesse H. Zabriskie insisted. He figured that if a missile contains 100 components, each of which is 99% reliable, the overall missile reliability is only 36.5%. If there are 300 components, overall reliability drops to 6%. The average missile, he added, contains at least 500 components which are critical from a functional standpoint. So it is imperative that each item possess practically 100% reliability.

H. B. Cheney of Consolidated Vultee remarked that if one can only get a whole missile to function properly on one flight, the rest of the missiles of that design seem to function with reasonably good reliability. Cheney showed the movie "A Ride on a Missile." Joseph Shortal showed and commented on an NACA film of missiles fired to gather aerodynamic data on airfoils and aircraft configurations. The session was also the occasion of the first public showing of a movie of the launching and flight of

the Matador guided missile. This was shown through the courtesy of the U. S. Air Force.

Packaging the Passenger

For crash safety, the total "packaging" around the passenger must be strong enough to maintain its integrity—yet ductile enough to absorb the crash energy. These two design aims aired by Hugh DeHaven pervaded the Symposium on Packaging the Passenger led by Jerome Lederer as chairman and sponsored by the Air Transport Activity.

It needn't be a case of sacrificing one aim for the other, engineers and medical men showed. The solution is an old one—build a strong outer container and an energy-absorbing inner package.

To insure the strength of their outer containers the Association of American Railroads specifies among other requirements that railroad passenger cars shall pass a severe "squeeze" test, American Car and Foundry's Allen W. Clarke related. The squeeze test involves application of an 800,000-lb static load longitudinally at the rear draft lugs. To qualify, the structure must take the load without failure of any members.

Speaking of the inner packaging in regard to passenger transports—that is the seats and other structures surrounding passengers—in terms used in packaging engineering, DeHaven said: Let the inner packaging immobilize the contained object (the passenger) to prevent movement and resultant damage from impact against the inside of the container. And let forces applied to the container be transmitted to the strongest parts of the contained object. DeHaven is with Cornell University Medical College's Department of Public Health and Preventive Medicine.

These two of his rules point toward rearward-facing seats, a feature the Military Air Transport Service has been trying out on trans-continental flights. Although he had no crash data to report, Lt.-Col. George Hewitt speaking for Lt.-Col. Edward A. Guilbert of MATS did disclose that passenger reactions, surprisingly enough, have been overwhelmingly favorable. MATS is now installing rearward-facing seats in some C-97's. The seats are designed to take 16g forward load with a 225-lb passenger or 24g with a 175-lb passenger.

The symposium recognized that one of the most important items in the package around the airplane passenger is, of course, the pilot. Dr. Ross A. McFarland urged that machines be designed from the man out, that instruments and controls be considered as extensions and appendages. McFarland, who spoke chiefly on human variables in the design and operation of ground vehicles, is with the Harvard School of Public Health.

At the other of the two Air Transport sessions, new developments in inner packaging of air cargo were discussed. P. A. Wood, Jr. was chairman.

Chester H. Chiodo told how Slick Airways uses rope nets and Web-Locks for tie-down. The nets are of $\frac{3}{8}$-in. rope in a 10-in. grid. The Web-Locks which secure the nets to the plane's tie-down fittings consist of web straps with self-locking quick-release mechanisms. The webbing doubles back through the fastening mechanism to give a me-

. . . Have You Heard This One

Spiked with humor were many of the talks, introductions, and corridor conversations. The following represent about 0.00001% of the total volume.

★ ★ ★ ★

New definition of an executive: "A big shot who hasn't been fired." (S. W. Sparrow)

★ ★ ★ ★

A man who greatly loved his wife, but seemed everlastingly unable to please her, received a blue necktie and a red necktie from her for Christmas. To show prompt appreciation, he put the blue one on immediately to appear at their yuletide dinner. . . .

His wife took one look and sniffed: "So, you don't like the red one, huh?" (J. C. Zeder)

★ ★ ★ ★

Man in a factory opens up his lunch box. His first sandwich turns out to be peanut butter—and he throws it away. The next turns out to be ham—and he eats it. Then he draws another of peanut butter and explains: "Damn it, I never did like peanut butter."

His companion says: "Doesn't your wife know you don't like peanut butter?"

To which first man responds: "Leave my wife out of this! I made these sandwiches myself." (Harry Knowlton)

★ ★ ★ ★

Practicing golf in his backyard, a duffer sets up a golf ball on an ant hill. He swings at it—but too low. He tries again, digs up almost the whole ant hill.

So one ant says to another: "Let's get on the ball, or we'll get the hell knocked out of us." (Harry Knowlton)

★ ★ ★ ★

"There's always room at the top, because the people up there go to sleep and fall off. . . .This process is called 'rusting on their laurels'." (Dinner speaker Dr. Kenneth McFarland)

chanical advantage when the strap is being tightened.

At the same session, F. A. Page and S. L. Bergen proclaimed that progressive overhaul definitely has profited United Air Lines. The progressive overhaul scheme in contrast with the conventional major-minor overhaul system, involves reapportioning overhaul chores so that each overhaul takes about the same number of man-hours. This avoids the extreme maintenance peaks that would have appeared with UAL's fleet of complicated DC-6's —almost all of which went into service about the same time and would reach major overhauls together.

Progressive overhaul has, according to Page and Bergen,

1. saved 6% on labor during the first cycle of overhauls and will save about 14% for the rest of the life of the fleet.

2. eliminated need for four hangars and docks at a total cost of $2,000,000.

3. added the equivalent of four DC-6's in service to the fleet.

Also at this Air Transport session, two papers were presented by title: "Statistical Aspects of Airline Reservations" by Charles Ammann of American Airlines, and "Lightning Protection for Transport Aircraft" by M. M. Newman of the Lightning and Transients Research Institute.

METALLURGISTS Study Various Ways To Conserve Material

IN three sessions on materials, metallurgists discussed these major steps in making the best use of available steels and iron:

- Reexamine designs to see if lean steels can be used for higher alloy steels or ductile iron for steel castings.

- Redesign parts if necessary or revise manufacturing processes.

- Learn more about what makes metals wear, so that parts can be designed to wear longer.

Materials men facing shortages of alloy steels for gears, shafts, bolts, and other automotive parts were urged by H. B. Knowlton of International Harvester to try substituting plain carbon or boron-treated steels. The easiest way to go about substituting, he said, is to find a leaner steel of minimum hardenability equivalent to that of the customary alloy at the point on the Jominy bar corresponding to the critical section of the part. Knowlton acknowledged that boron steels may not be as tough as some other alloy steels. But he felt that boron steels have enough toughness, if properly processed, for many applications. If a steel has enough toughness to prevent brittle failure, additional toughness has no value, he reminded his listeners.

Roy Roush reported that Timken-Detroit Axle has used between 20 and 25 million lb of boron steels, thereby saving 250,000 lb of nickel. When asked if he had had any trouble with distortion of boron steel gears, Roush said, "Of course, we get distortion. You never saw a gear man who wasn't up to his neck in trouble, did you? I've never run across a new gear steel you could carburize and harden without any distortion. But we always get out of it in time." Roush added that his company is going to steels of lower hardenability for certain small gears to get away from distortion.

For engineers eager to try ductile iron in their products, there was information on effect of chemistry and section size on properties. It was presented by D. J. Reese of International Nickel, F. B. Rote of Albion Malleable Iron, and G. A. Conger of the University of Michigan.

They reported that maximum strengths can be secured in the as-cast condition by balancing composition and thickness. In general, compositional control should be based on silicon content, rather than carbon or phosphorus contents. Carbon exerts little effect on strength or other properties. Phosphorus decreases the as-cast strength and should be held as low as practical.

Maximum strength in all sections is secured at 1.5-2.5% silicon, the three metallurgists revealed. Tensile strengths in excess of 100,000 psi can be achieved in 1 to 2-in. sections. Strengths as high as 130,000 to 150,000 psi can be obtained by oil quenching or air cooling, then tempering at 1100 to 1200 F or by isothermal transformation at 1100 to 1200 F.

Maximum elongation is obtained by full annealing of ductile iron to produce a fully ferritic matrix. Elongations over 25% are possible in sections up to 3 in. thick, it was reported.

Material saving was one of the virtues claimed for the recently introduced "shell" molding process, also discussed by iron-casting experts. The savings result from use of smaller gates, risers, and sprues.

The process was described in a paper by H. L. Day of Auto Specialties Mfg. Co. and R. A. Flinn and K. F. Packer of the University of Michigan. As they explained it, the cast iron or aluminum pattern is

heated to 350-500 F. A dry mixture of sand and resin is dumped over the pattern and allowed to set for a few seconds. When the pattern is removed from the bulk of the mixture, a thin sand-resin shell adheres. Pattern and adhering shell go into a 600 F oven to cure the shell before it is stripped off.

Two or more of these shell segments are assembled into a book-type mold and firmly backed up with metal shot. Then the shell molding is ready for pouring.

Besides saving casting metal, the process offers the big advantage of producing a smoother surface on the casting than sand casting methods do. In many cases, it was reported, the degree of finish is satisfactory for replacement of die castings of strategic light metals by ferrous metals.

Aircraft powerplant metallurgists are working on conservation measures involving changes in parts design and processing. R. H. Thielemann, J. C. Mertz, and W. P. Eddy, Jr.—all of Pratt and Whitney Aircraft—reported attempts are being made to develop protective coatings which will make possible use of heat-treatable carbon and low-alloy steels for all steel parts of jet engines reaching temperatures no higher than 900 or 1000 F. Protective coatings over lean steels are already saving considerable chromium in compressor parts.

A new iron-base alloy containing 20% chromium, 35% nickel, and 1.0% titanium is now under test for sheet-metal parts subjected to gas temperatures of 1200 to 1800 F, the three metallurgists continued. If the new alloy proves satisfactory, its use can save worth-while amounts of nickel.

These materials-conservation papers were presented at sessions sponsored by the Engineering Materials Activity with P. R. Wray and A. W. Demmler as chairmen.

The Tractor and Farm Machinery Activity in its session explored another approach to conservation —build machinery to wear longer.

That doesn't necessarily mean going to the expense of achieving the smoothest possible finish, said R. A. James speaking for C. R. Lewis, both of Chrysler. As Lewis explains it, smooth surfaces may wear so slowly that very long run-in is required to compensate for manufacturing tolerances, assembly deflections, and thermal distortions. Asperities of rougher surfaces, being more highly loaded, break off earlier, thus distributing the load unevenly and preventing scoring or seizing.

Another way to minimize the build-up of high loads on a metal surface is to start with a metal capable of relatively large elastic deflection, T. L. Oberle of Caterpillar pointed out. The elastic limit of stress for a material is seldom reported as such, but an indication of its magnitude can be obtained by dividing its elastic limit of stress by its elastic modulus. A more convenient value for total elastic deflection may be obtained by dividing Brinell hardness by elastic modulus. This latter quotient multiplied by 10^6 Oberle called the Modell of a material. The higher the Modell rating, the better a material can be expected to wear.

Oberle's table of Modell values showed alundum at the top and other common metals descending in Modell value in this order: hard gray iron, tungsten carbide, hardened steel, hardened aluminum alloy, as-cast gray iron, soft structural steel, pure lead, pure tin.

Reaction to the Modell-index concept was generally favorable. R. H. Bancroft of Perfect Circle acclaimed it as "a great big furlong stride in taking the evaluation of wear out of the realm of cloudy empiricism into that of a science with a working formula." J. T. MacKenzie of American Cast Iron Pipe pointed out that the Modell index resembles a formula the pipe industry uses to estimate the toughness of cast pipe; the pipe formula says that the resilience is equal to the square of the stress divided by the modulus of elasticity. Oberle explained that he, too, had considered using the square of the hardness in his expression, but since there weren't enough data available to indicate whether the square or the first power was better, he chose the simpler term.

Session Chairman R. C. Williams announced two other papers presented by title at this Tractor session. They were "Beam Strength of Spur Gears—When to Use the Higher or Lower Strength Factor" by R. P. Van Zandt of Caterpillar, and "The Natural Frequency Equation Applied to Farm Tractors" by P. L. Mikeska of International Harvester.

Engineers Gather To Discuss Design and Future Trends of MOTOR VEHICLES

PAPERS presented at ground vehicle sessions covered a wide variety of subjects . . . ranging from the motivation behind the styling of the Chrysler K-310 to using the Gulp Factor as a design parameter for securing high volumetric efficiency. Experts in many fields gathered to share and exchange the latest information on styling, power steering, ball-joint front suspensions, safety and volumetric efficiency.

Many new design concepts were outlined at these sessions sponsored by the Truck and Bus, Passenger Car, and Body Activities. Two papers presented at the "Packaging the Passenger" symposium, sponsored by the Air Transport Activity, contributed more of the same. Serving as chairmen at these ground vehicle sessions were J. C. Zeder, H. H. Hooker, E. H. Smith and R. Schilling.

Designers learned that styling of the K-310 is the

Forty-four to One

Frederick E. Moskovics (M '08), attending his 44th SAE Annual Meeting, chatted with Philip D. Marriner (J '51) who was attending his first. Moskovics is industrial consultant to A. O. Smith Corp., and Marriner is in Chrysler's engineering department

result of translating certain international design influences into a new American theme.

National schools of thought on automobile design—British-Traditional, German-Functional and Italian-Simplicity—are reflected in the final design, Chrysler's V. M. Exner noted.

It is Traditional in that the lines are strong and classic; Functional in that emphasis is placed on the function of individual components; and represents Simplicity in that the whole design, bumper to bumper, is perceptibly unified, he went on to say.

The wheel, the essence of functional automobile design, was the keynote to K-310 styling, it was brought out. Large diameter wire wheels were used to give better proportion to the overall style of the car, he stated, and create the impression of lowness —another British and Continental styling feature.

The basic wheel shape was carried to the tail, stop, and directional light signals. For example, Exner explained, the tail light is mounted separately to accent—by contrast—the unity, function, and smoothness of the rear end design.

Besides, this stylist added, the "round" or "wheel" design motif was extended from the exterior to the steering wheel, instruments, and trim so that the entirely-integrated and gadget-free interior would be marked by simplicity and luxurious comfort.

Further Use of New Products Indicated

"After a slow start, power steering today is moving fast," reported W. K. Creson of Ross Gear and Tool Co. It was original equipment on one make of car in 1951—but, he noted, in 1952 it is expected to be on at least five. Heretofore applied to rugged, off-the-road equipment, 1952 bids to extend its use in far greater volume to truck operations on the highway, Creson continued.

Overall production of power steering for cars and trucks is something like 10,000 for 1950, 40,000 for 1951, and more than 200,000 for 1952.

Further rapid growth of power steering is indicated, Creson predicted, because it lightens work, contributes to safety, and especially because its major technical problems, including cost, are yielding to years of testing and development.

A tremendous increase in the use of power steering is indicated, agreed C. W. Lincoln of General Motors' Saginaw Division. This is especially true in the passenger car field, he added, where the trend toward greater car weight and larger and softer tires has brought about a definite need for this device.

Ball-joint front suspensions, also, are entering the passenger car picture, it was brought out. Functional difficulties and high cost, which discouraged their acceptance by the American automotive industry in the past, have been largely overcome, J. H. Booth of Thompson Products observed.

The Thompson Products design eliminates such objectionable features as high turning torque and large size of units, according to Booth.

Turning resistance has been reduced by transferring the steering motion from a spherical load-carrying surface to a ring of balls. Along with this modification, he added, a dampening force has been provided by placing a spring-loaded clutch in the upper ball joint—where a small portion of the car weight and braking forces is concentrated.

Most important of all, Booth noted, cost of this unit is competitive with its "pin-pushing-kingpin" counterpart. Cost studies show weight savings, eliminated operations, reductions in parts, and design improvements made possible by the ball joint adaptation.

Advantages of this upper and lower ball-joint front suspension are reflected in the new 1952 Lincoln, another author pointed out.

Improved performance, said E. S. MacPherson of Ford, is manifested in better riding quality with more wheel travel, easier steering with lower bearing loads, and nicer handling with controlled uniform friction and reduced toggle effect. (In MacPherson's absence, his paper was presented by Phil H. Pretz of Ford.)

Excellent serviceability of this unit is another benefit gained, this engineer emphasized. There are only four grease fittings, all of which are easily accessible, he noted. Simpler caster and camber adjustment do not require special tools. Furthermore, MacPherson added, replacement can be made without special tools or realignment of suspension, resulting in at least 50% service time saving.

This suspension design also allows more usable space in the engine compartment, and more readily permits the use of various types of engines and arrangement of their components, MacPherson concluded.

Emphasize Designing for Passenger Safety

Design for passenger safety was the theme of two papers presented at the "Packaging the Passenger" symposium. Set up minimum standards for construction, stressed one engineer. Design equipment in terms of human capabilities and limitations, a second advocated.

A. W. Clarke of American Car and Foundry was the engineer who emphasized the importance of setting up minimum standards for car construction.

Railroad passenger cars, he noted, must be built in accordance with specifications adopted by the

Association of American Railroads. These include all the Railway Mail Service framing construction requirements, Clarke pointed out, as well as a compression test of the entire structure.

These A.A.R. and R.M.S. specifications insure, the speaker noted, structures that will not fail except under the most severe wreck conditions . . . members that resist telescoping and absorb impact energy in relatively short distances . . . resistance to destruction of the side wall in case of side-swiping or overturning. In total, Clarke went on to say, they add up to a number of major provisions for the protection of passengers in the event of any sort of accident, derailment, collision or overturning.

"That this has been a wise policy," he said, "is indicated by the low average rate of train accident fatalities per billion passenger miles, which has prevailed over the last forty years."

Ross A. McFarland of Harvard urged that equipment be designed in terms of human capabilities and limitations. Machines should be designed from the man outward, he asserted, with the instruments and controls considered as extensions of his nervous system and body appendages.

All possible faults in equipment . . . in the working area . . . as well as the capabilities of the operator, should be subjected to an advance analysis if accidents are to be prevented, McFarland emphasized.

"If this point of view is carried out in practice," he said, "fewer accidents should result, training costs should be reduced, and extensive redesigning of equipment after it is put into use should be eliminated."

Note Use for Gulp Factor as Design Parameter

Still another design consideration was brought to light by M.I.T. researchers J. C. Livengood, A. R. Rogowski, and C. F. Taylor.

The Gulp Factor is a critical design factor in designing any kind of reciprocating engine so as to secure high volumetric efficiency, they pointed out.

This inlet-valve Mach Index, it was explained, takes into consideration mean piston speed, sonic velocity in the fresh mixture at inlet conditions, piston area, valve area, and the average flow coefficient.

Volumetric efficiency falls rapidly with increasing values of Gulp Factor above 0.6, the trio noted. Tests also showed, they added, that—with a given cylinder size—Gulp Factor could be lowered equally well by decreasing piston speed, increasing inlet-valve diameter, or by increasing the inlet-valve flow coefficient. These relations show conclusively, the group declared, that there is little gain to be had by increasing inlet-valve size or flow coefficient when the Gulp Factor is less than 0.6.

Furthermore, tests indicated that—with a given valve overlap and a given ratio of exhaust pressure to inlet pressure—volumetric efficiency is still a function of the Gulp Factor.

In addition, it was brought out, barring serious interference between cylinders, the trend seems to be for the optimum closing time of the inlet valve to be later as the Gulp Factor increases. Thus, either high piston speed or a small inlet valve (relative to the piston area) calls for late inlet-valve timing to secure maximum volumetric efficiency.

Discussers D. F. Caris and L. R. Papenguth of General Motors' Research Laboratories acknowledged the potential value of the Gulp Factor, but pointed out that more work is needed to make this parameter useful for predicting multicylinder engine volumetric efficiencies. They reported that the Gulp Factor has been applied to two multicylinder engines. And, these researchers brought out, the high volumetric efficiencies obtained by the authors on the single-cylinder laboratory engine at values of Gulp Factor below 0.6 were not always obtained.

Emphasize Need for Care in Selection and Maintenance of FLEETS

INTELLIGENT selection of vehicles for fleet use pays real dividends, especially when followed up by sound engine maintenance practices. This maxim—the consensus at Transportation and Maintenance sessions—found ready support in specific rules and concrete procedures outlined by speakers.

Many important points should be considered in choosing passenger cars, light-duty and heavy-duty trucks for fleet operation, one engineer emphasized. Outstanding are ability of the vehicle to meet service requirements, possibility of using standard rather than special equipment, and the manufacturer's service policy.

While savings can result from careful selection—without proper maintenance—they may not be realized, other papers brought out. The down time of any unit for repairs is costly. Not only does the unit become non-productive, but costs of repair materials and labor become additional expenses.

Adherence to sound maintenance practices can bring about sharp reductions in engine failures, caused by faulty bearings, rings, pistons, cylinders, and valve gear. Several positive approaches can be used to bolster both the efficiency and life of these parts—thus reducing repair and replacement costs:

- Proper installation of engine bearings.

- Use of the proper type lubricant during engine break-in, and slight interference fits when instal-

ling dry sleeves; plus resizing and otherwise altering the pistons.

- Correct valve lash setting.

These ideas were expressed at sessions sponsored by the SAE T&M Activity. Serving as chairmen at these sessions were J. A. Harvey, 1951 SAE Vice-President, and Linn Edsall, 1952 SAE Vice-President for this Activity.

H. D. Johnson of the U. S. Dept. of Agriculture presented a paper by title at one of these sessions entitled, "Refrigeration in the Transportation of Frozen Citrus Concentrate by Motor Truck."

Factors in Vehicle Selection

Intelligent selection of fleet vehicles is a challenge, noted H. O. Mathews of Armour & Co. To insure that a good job is done, the fleet manager must know the service requirements in detail and be able to evaluate them in terms of equipment available.

One of the prime considerations, Mathews brought out, is to avoid the use of vehicles of special design or with special equipment. Most service requirements can be adequately met by using standard vehicles with factory installed options. The availability of various types of equipment and the options which can be specified and installed during production must be known, he added. Naturally, there will be many compromises necessary to accomplish the desired results, Mathews went on to say, but time given to this all important problem pays off in the long run.

However, he stressed that very little compromise can be considered in the selection of heavy-duty trucks. These vehicles must meet operating requirements in every detail. Unless they do, the variety of uses to which the vehicles are put will cause components to fail in service due to the wrong application. The best solution, Mathews felt, is to select an engine which will meet all the operating requirements, then try to match the other components and chassis to it.

Manufacturer's service should also play an important part in the selection of fleet vehicles, it was emphasized. Many dealers have no interest in the servicing of passenger car and medium-duty truck fleets, Mathews pointed out. Others, however, can be relied upon to provide economical maintenance, he added.

Conditions are appreciably better, Mathews continued, in the case of heavy-duty trucks, manufacturers of which have recognized the importance of specialized maintenance service. In this case, several plans are available to the operator—100% manufacturer's service at labor cost plus parts, guaranteed maintenance service which predetermines the cost per mile over the life of the vehicle, and 100% company service. The operator may find it advisable to use two or three of these services to determine which is most economical for him.

Other points which should be considered in selecting fleet vehicles are inherent safety of design, driver comfort, likelihood of early obsolescence, and legal limitations, added F. K. Glynn of American Telephone and Telegraph.

Discusser A. Walter Neumann described one method used by Willett to choose the "right" vehicle. Equipment is evaluated on a point system, he said, taking initial cost, performance, and driver reaction into consideration. Then, barring unsatisfactory performance, the vehicle receiving the most points is purchased, Neumann pointed out.

Proper Installation of Bearings Important

Engine bearings can and do last a long time if they are properly installed and maintained, observed author W. E. Thill of Federal-Mogul Corp. Good maintenance practices embody the principles of maintaining a round hole for a round shaft under proper oil clearance conditions. Cleanliness and care in assembling are basic considerations, he pointed out.

Thill said that proper installation of engine bearings calls for making sure that:

1. The housing (connecting rod or main bearing saddle) into which the bearing is to be assembled is round, reasonably smooth, straight, and the proper size.

2. The new insert bearing is the correct undersize for the replacement, is of the proper materials, and has similar grooving and oil holes.

3. The crankshaft is round, smooth and straight, and the correct size.

4. The oil clearance is correct.

5. Good clean oil is supplied to the bearings under pressure.

"Deviations from practical limits on any of these," he emphasized, "can lead to trouble in the form of shortened bearing life or possible immediate failure."

Ring-Piston-Cylinder Maintenance Stressed

The rings, piston, and cylinder still represent—with few exceptions—the life limiting components of present day engines, noted H. G. Braendel of Wilkening Mfg. Corp. These parts wear out faster, break more often, stick, and freeze more frequently than any other engine parts. Consequently, they can be costly components unless properly maintained.

For example, Braendel continued, use of the proper type of lubricant during the first several thousand miles of engine operation can cut down on failures due to lack of seating of the rings and cylinder. The correct oil in this case is a non-additive or lightly-additive lubricant. Studies indicated that heavily additive lubricants formed a polar arrangement or metallic plate of the surfaces, preventing metal-to-metal contact and the necessary abrasion of the peaks in the mating surfaces. However, Braendel added, after initial seating takes place, the highly fortified oils will give good results.

Another sound maintenance practice, according to this engineer, is to install dry sleeves with either a very slight interference or a slip fit. Longer cylinder and ring life, plus less blowby, are direct benefits of the resulting decreased cylinder distortion, it was brought out.

Braendel also recommended resizing worn pistons which are otherwise serviceable from the groove wear standpoint. Resizing reduces relative motion between the piston and cylinder to a minimum, he explained, bringing about better ring life in both worn as well as new cylinders.

"One of the best methods to resize heavy-duty pistons," Braendel said, "is to knurl both sides of the skirt to provide at least original specification side clearance." Furthermore, he added, pockets of lubricant retained by the knurled surface prevent scuffing to such a degree that closer piston fits can be employed than are possible with new conventionally-finished pistons.

Other piston alterations, Braendel noted, which can be easily accomplished during engine rebuilding, will greatly improve oil control of the installation regardless of the type of rings used. Oil control, drainage and supply conditions can be improved by:

1. Cutting a sharp edge at the bottom of the skirt.
2. Providing an undercut or bevel just below the oil-control groove and drilling additional holes into the inside of the piston.
3. Making an undercut on the land between the oil-control ring and the lowest compression ring.

The most important factor in good valve maintenance is correct lash, two Thompson Products engineers emphasized. Proper settings may not be responsible for desired valve life, J. A. Newton and N. Hoertz brought out, but improper ones can be, and are, the cause of several undesirable conditions. Specifically, they noted, insufficient operating clearances can reduce valve life to as little as 25% of normal.

Unless otherwise instructed by the manufacturer, lash adjustment should be made on a thoroughly warmed engine, Newton-Hoertz pointed out. Such conditions as temperature of the water, oil, block, head, and valve gear can cause wide fluctuation in the valve lash readings between a cold and a warm engine.

Guide wear should also be carefully watched, these speakers emphasized, because it affects the overall valve temperature. As guide clearance increases, they explained, there is less contact between stem and guide, and likewise less heat conductivity, giving a temperature rise in both valve stem and head. Higher clearance also, they added, allows movement of the valve on the valve seat insert, causing wear and gas leakage—factors that contribute to valve burning, loss of compression, and power.

SAE Engineers Hear News Of Current Moves From MILITARY MEN

NEWS about military procedures which impinge widely on the work of automotive engineers came to the Annual Meeting from Maj.-Gen. Francis H. Griswold, and Col. H. H. D. Heiberg. General Griswold, military director of the Munitions Board, pled strongly for realistic figures from industry in claims for CMP materials. Colonel Heiberg, representing the views of the users of military equipment — the soldier in combat — stressed the Army Field Forces' interest in the progress of each piece of military equipment "from the cradle to the grave."

(Chairman of the session at which Colonel Heiberg spoke was SAE 1952 Vice-President F. W. Kateley—and the session was sponsored by his Truck & Bus Activity. R. J. Emmert, SAE 1951 Production vice-president, chairmaned the Production-Activity-sponsored session at which General Griswold's presentation was made.)

If industry claims for CMP materials are too high, General Griswold explained, then automobile and other civilian production is unnecessarily cut back. If they are too low, military production schedules aren't met.

Appropriation of 50 billion dollars in the current fiscal year for military equipment and expansion of production facilities, he pointed out, emphasized the magnitude of the present Munitions Board job. Basically, he said, that job is to insure that the military services get what they need at the time necessary to meet the war plans of the Joint Chiefs of Staff—*and with minimum disruption of the civilian economy.* The principles upon which the Board is administering its work, he said, closely parallel proposals made last fall by General Motors President Charles E. Wilson for the establishment of dual purpose plants for both peace and war.

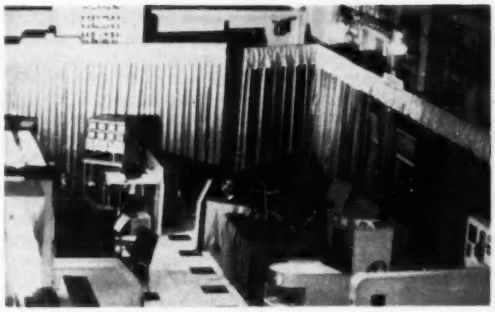
In stockpiling, as well as in other functioning, the Munitions Board has full regard for effects on civilian economy as well as on military needs, General Griswold indicated. The stockpile, he said, is national in scope, not just military. Its targets are set by the Munitions Board, although the Defense Production Administration is the key control agency. "It will provide," General Griswold promised, "for the industrial and essential civilian wartime needs as well as those of a direct military nature."

A grand total of 5 billion dollars has now been authorized for stockpiling purposes, General Griswold revealed, adding: "We have on hand 36% of the total quantities of stockpile materials we would

Continued on Page 76

Exhibitors at the

Aeroquip Corp.
Aluminum Co. of America
Aluminum Industries, Inc.
American Bosch Corp.
Auto Specialties Mfg. Co.
Bendix Aviation Corp.
Brush Development Co.
Buda Co.
Campbell, Wyant & Cannon Foundry Co.
Cities Service Oil Co.
Cleveland Graphite Bronze Co.
Consolidated Engineering Corp.
Continental Motors Corp.
Cummins Engine Co.
DeLuxe Products Corp.
Dualoc Drive, Inc.
Allen B. Dumont Laboratories
Elastic Stop Nut Corp. of America
Fram Corp.
Garlock Packing Co.
Gemmer Mfg. Co.
General Plate Div. Metals & Controls Corp.
Hercules Motors Corp.
Koppers Co., Inc.
LeRoi Co.



Engineering Display

Link Engineering Co.
Lisle Corp.
Lord Mfg. Co.
MB Mfg. Co.
Mechanics Universal Joint Division,
Borg-Warner Corp.
McQuay-Norris Mfg. Co.
Monroe Auto Equipment Co.
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Controls Corp.
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Stewart-Warner Corp.
Sun Electric Corp.
Titeflex, Inc.
Torrington Mfg. Co.
Vickers, Inc.
Victor Mfg. & Gasket Co.
Waldes-Kohinoor, Inc.
Waukesha Motor Co.
Zollner Machine Works

need to fight a major war. We are making progress, but we have a long way to go."

In the past year, he concluded, "the Munitions Board has passed from purely planning for industrial mobilization to an active and vigorous participation in the current procurement and production programs to build up the armed forces."

Colonel Heiberg explained that each new pilot model of a piece of military equipment goes both to the developing agency for engineering tests and to the appropriate Army Field Forces Board for service tests.

The Army Field Forces Board No. 2—which operates the Fort Knox test facilities and programs—is responsible for five major areas of service testing:

(1) All automotive equipment of the field army; (2) direct fire weapons and fire control equipment; (3) all engineer equipment of the field army; (4) all medical equipment of the field army; and (5) maintenance and supply procedures applicable to the foregoing equipment.

Automotive testing of a typical truck, Colonel Heiberg said, involves 18 different tests, each of which is carefully controlled to fulfill a specific, predetermined purpose. In addition to pilot model tests, he said, early production models usually are tested, too. Any changes introduced into production have to have a Field Forces Board blessing.

PRODUCTION

Men Hear about Device To Increase Tool Life

A NEW development claimed to increase metal cutting tool life from 3 to 12 times and produce parts three times as smooth as by conventional methods was described at the session held by the Production Activity, with R. J. Emmert as chairman.

Wide use of the device will nearly double America's metal cutting capacity, according to R. J. S. Pigott of Gulf, the inventor, and A. T. Colwell of Thompson Products, Inc., coauthors of the paper, "Hi-Jet System for Increasing Tool Life."

Small, high-speed jets of cutting oil are directed at the metal cutting tool from below instead of large amounts of coolant being flushed from above, as is conventionally done. This efficiently lubricates the cutting tool, according to the authors.

Heat transfer from the cutting tool point is achieved three times as rapidly as heretofore and only one-twentieth the amount of oil is used.

As a result of the more rapid cooling of cutting tools, the machine operator can run his lathe or other cutting tool three times as fast with the same tool life as now, or operate his machine at present speeds and extend tool life from three to 12 times, depending upon the tool material, the speakers pointed out.

Thus, the authors concluded, production on a metal cutting machine, now in critical supply because of expanding national defense work, can be tripled.

F & L ENGINEERS

Discuss How to Get Engine Cleanliness

THE proverb, "Cleanliness is next to Godliness," applies to engines as well as humans, if the papers presented at the F&L sessions are any criterion. They reflected clearly with what seriousness the automotive industry views the problem of attaining engine cleanliness. The elimination—or at least reduction—of deposits—particularly those in the combustion chamber—was said to be an important part of the never-ending search of the laboratories for ways to utilize fuel more effectively.

(Chairmen of these sessions were SAE Diesel-Engine Vice-President W. G. Ainsley and SAE Fuels & Lubricants Vice-President J. G. Moxey, Jr.)

As discussed in various papers, combustion-chamber deposits can lead to afterrunning, autoignition, preignition, and knock; they can reduce valve life and spark-plug performance; they can also cause an appreciable power loss.

The piston is another important part of the engine that needs to be kept clean. In particular, deposits in the grooves can lead to ring sticking, according to other authors.

Deposits in the crankcase and other parts can be excessive under certain severe operating conditions, as discussed by another speaker.

But what can be done about these deposits? Many factors have been found to influence them—fuel, lubricant, engine design, operating conditions, and maintenance.

As far as operating conditions and maintenance are concerned, the engine designer and the petroleum engineer, it was agreed, just have no control over them. The best they can do is to make recommendations about proper maintenance, accept the operating requirements of the customer as they are—and hope for the best.

This leaves the engineers with fuels, lubricants, and engine design on which to practice their skills. As far as combustion-chamber deposits are concerned, it was shown that greatest gains can be made by way of improvements in engine design, although better fuels and oils can also bring modest help that shouldn't be sneezed at.

Piston deposits and ring sticking in diesel engines were shown by one speaker to be affected by both fuel and lubricant quality. Fuels of low sulfur content and oils containing additives are both helpful in reducing deposits, according to the evidence.

That the cleanliness of gasoline engines is also aided by the use of additives in the oil was shown by another speaker. His tests demonstrated, however, that certain design modifications resulted in more improvement than that obtainable with additives in the oil.

Combustion-Chamber Deposits

Autoignition—Flame photographs taken by L. L. Withrow and F. W. Bowditch, of the GM Research Laboratories, with a high-speed motion picture camera showed, in general, that combustion-chamber deposits, in the process of purging themselves, eliminate one problem, namely, the tendency for the combustion space to fill with solid material and, at the same time, create another one—autoignition and wild ping.

Ignition, their picture showed, is induced by particles of incandescent deposit moving in the gaseous mixture as well as by deposits attached to the walls. Apparently, as the deposits are being removed from the walls, they sometimes become sufficiently active to start normal inflammation before they leave the engine.

As a result of their photographic studies, the authors made the following deductions:

1. It is possible for the deposits to be igniting the fuel-air mixture in advance of the normal flame fronts and still not cause the engine to continue running after ignition is turned off. Autoignition or afterrunning, as normally defined in customer service, can only occur when the deposits on the walls are so active that the mixture is ignited at the pressures and temperatures that develop at or near TDC under the degree of compression developed by the piston alone.

2. It is obvious that the effects of deposits on the general character of the inflammation process may be alleviated by advancing the spark. It is well known, however, that this simply amplifies the knock problem. Finally, it is also obvious that, under certain operating conditions, the deposits may be distorting the nature of the inflammation process in nonknocking explosions as well as in knocking ones, thereby decreasing engine efficiency and reducing fuel economy.

Power Loss—Roughly two-thirds of the loss in power that comes from the presence of deposits, said H. J. Gibson, C. A. Hall, and A. E. Huffman of Ethyl, is due to decreased air consumption and one-third is due to reduced thermal efficiency. The decreased consumption, they said, is the result of physical and thermal restriction of the intake charge. (Thermal restriction, they define, as the reduction in the amount of incoming charge caused by a transfer of heat from the deposits to the charge.)

It appears that in most automotive engines physical restriction of the intake charge by the deposits is negligible. Thermal restriction, on the other hand, is of primary importance, occurring in varying degrees in all engines, according to the authors.

Engine Design—All agreed that changes in engine design can bring the greatest reduction in combustion-chamber deposits.

For example, D. E. Carr, L. A. McReynolds, S. C. Britton, and R. E. Linnard, Phillips Petroleum Co., pointed out that variations have been found of up to 20 octane numbers for the fuel requirements of new engines of the same make and model, as compared to the 8-12 octane-number increase normally caused by deposits after about 10,000 miles of passenger-car operation. These variations seem to indicate a need for improvements in both engine design and methods of manufacture.

According to Withrow and Bowditch, the mechanical octane numbers designed into some combustion chambers may be depreciated by the autoignition induced by deposits. The depreciation, they said, may be expected to be most pronounced in those designs that require accurate control of the time and place of ignition, as well as the direction of flame propagation, once it is initiated. In view of these many opposing influences, they feel that customer experience must finally determine the design that offers the best compromise.

As a result of their studies Gibson et al made the following suggestions for engine designers:

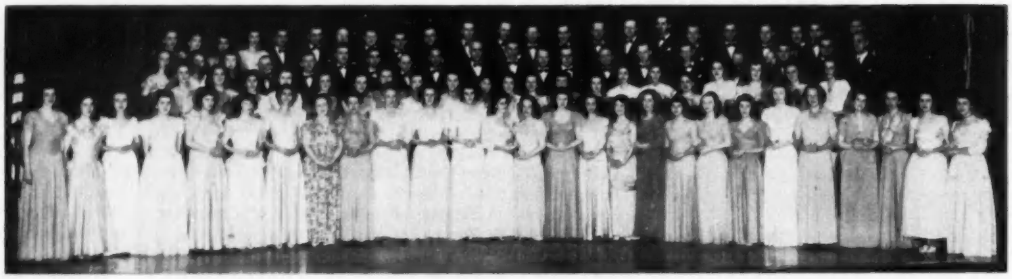
1. Provide for introduction of the intake charge with minimum contact with deposit-coated surfaces.

2. Keep the ratio of combustion-chamber surface area to engine displacement at the minimum value permitted by other design considerations.

3. Provide for adequate open areas around the intake valve so that deposit buildup will not cause physical restriction of the incoming charge.

Fuel—Gibson and his coworkers also reported on the effect of changes in the fuel. Briefly, their conclusions were:

1. Tel concentration: The presence of tel in fuel increases deposit weight over that with clear fuel by several times and, under the severe constant-speed, constant-load conditions of most laboratory tests, power loss is also increased. Under more typi-



Entertainment feature of the Annual Meeting Dinner was a series of songs from Broadway hits by the Ford Motor Co. Chorus. Under the direction of Ray C. Kooi, this large chorus of mixed voices delighted the entire audience of engineers

cal service, however, different results were obtained. For example, a study of engines used in heavy-duty fleet service showed the deposit weight pattern to be similar to that obtained in the constant-speed tests, but the loss of power caused by the deposits was independent of tel concentration.

2. Fuel composition: Again under constant speed and load (as being most severe, although not typical) the tests showed that, with leaded fuels, increasing unsaturation generally means lowered quantities of deposit. (The effect of increasing unsaturation is important because of the trend toward greater use of cracked and reformed stocks.)

3. Sulfur content: The data indicate that sulfur content has no significant effect on deposit weight in road operation, either passenger car or truck.

In the case of both degree of fuel saturation and sulfur content, sufficient data are not yet available for the authors to determine the effects of these variables on power loss.

Lubricating Oil—Although the effects of changes in oil are small, compared with mechanical and manufacturing variations among similar engines, several speakers insisted that this should not deter the petroleum industry from trying to develop oils with a lesser tendency to contribute to deposits. They feel that the deleterious effects of deposits are so great that any improvement that tends to alleviate the problem, even to a nominal extent, will be of major significance.

Although deposits used to consist mainly of carbonaceous matter, the trend now is toward increased amounts of metallic constituents from the additives being used. The work of Carr et al shows, however, that a substantially ashless detergent gave more deposit (although less octane requirement increase) than the additive blend having the highest ash content.

The authors conclude that, at least under the severe operating conditions of their tests, the ash-forming constituents in an oil tend to act as modifiers of the lead compound deposits, and as such affect spark-plug and valve performance much more than octane requirement increase or power output.

In discussion, W. A. Howe of Gulf reported, however, that under certain conditions, according to their field tests, high concentrations of certain additives can actually increase valve and spark-plug life and reduce to a small degree the octane-number requirement increase.

Other Deposits

Information about deposits in other parts of engines was presented for both diesel and gasoline powerplants.

Diesel Engines—H. C. Morris, Texas Co., found that, when using a given fuel, there appears to be a definite relationship between exhaust smoke, used oil condition, piston temperature, and piston deposits, such that:

1. In the no-smoke region fuel combustion is substantially complete and piston temperature goes up with increasing fuel/air ratio. Under these conditions piston deposits are primarily controlled by lubricant deterioration, which increases with rising piston temperature and also with increasing fuel/air ratio.

2. In the smoke region piston temperature is relatively constant and deposits are governed primarily by the amount of incomplete fuel combustion products, which become greater with increasing fuel/air ratio and with wider throttle opening.

Fortunately, the author said, this classification corresponds to a division that can be made in commercial engines, and thus assists in the selection of lubricants for particular types of service. For example, marine, stationary, and some railway diesels characteristically operate in the no-smoke region, where combustion is substantially complete. Thus their principal requirement is for a lubricant that possesses good oxidation stability, either occurring naturally or enhanced by the use of additives. In contrast, diesels used in automotive and other applications of high specific power outputs

operate at relatively high piston temperatures in the smoke region. They thus require a heavy-duty oil that offers, in addition to oxidation stability, detergency and dispersive characteristics to combat the effects of incomplete fuel combustion products.

The various hydrocarbon types existing in diesel fuels appeared in these tests to exert some influence on deposit formation, although it was not possible to establish the specific relationships involved. Sulfur compounds in the fuel, on the other hand, were found to have an accelerating effect on deposit formation. Additive oils containing detergents and antioxidants did, however, help to reduce deposits stemming from both the sulfur present in the fuel and the soot caused by incomplete combustion.

Gasoline Engines—Although, said A. C. Pilger, Jr., Tide Water Associated Oil Co., the advantages of using oils containing detergents have been pretty well established for the diesel field, considerable difference of opinion has continued to exist regarding their usefulness for gasoline engines.

As his contribution to knowledge on the subject, he has, therefore, made a comprehensive study of the effectiveness of detergent oils in overcoming deposits (on pistons, rings, valves, top and side covers, oil screen) under three specific types of service, which are critical from this standpoint, as follows:

1. Heavy-duty highway truck tests. The following summarizes the data from these tests:

(1) Incorporation of inhibitor-detergent compounds effectively improved engine cleanliness with the base oils studied.

(2) The degree of improvement was not reliably related to oil type classification when variations in base stock and additive compositions were introduced.

(3) Maximum cleanliness performance for each detergent oil classification was obtained by selecting the most effective base-stock, additive combination under service conditions rather than by merely meeting the type-classification engine test requirements.

(4) Copper-lead bearing corrosion was found to influence engine cleanliness to nearly the same extent as the wide variations in detergency studied.

(5) Compared with detergent oil performance, reduction in oil drain period was found to produce consistent and substantial improvement in engine cleanliness.

2. Light-duty pickup and delivery tests. Some idling, frequent starts and stops, and virtually no high-speed driving characterized this operation. Here, the particular problem seems to be wet sludge deposits, because for new vehicles heavy deposits of this type frequently occurred in less than 2000 miles during the winter months. In this operation the author found that:

(1) Detergency can be effective in combating wet sludge deposits.

(2) Type classification is not, however, a reliable guide to the ability of a lubricant to cope with this problem.

(3) An effective oil can be selected with certainty only by field evaluation.

(4) The combined use of positive crankcase ventilation, oil filtration, and high-temperature thermostat resulted in a marked improvement in engine cleanliness, even greater than was obtained by improvements in oil characteristics.

3. High-speed cross-country passenger-car operation. Because the light-duty passenger-car operation was believed to be covered fairly well by the city pickup and delivery tests, this left the high-speed cross-country driving at the other end of the operating range to be investigated. The data of the author indicated that:

(1) Detergency is effective in combating deposit formation.

(2) With reduced oil drain periods engines remain cleaner.

(3) Oils intended for passenger-car use should be evaluated in this form of service rather than by relying on heavy-duty truck tests, where the order of merit may be different.

(4) Piston varnish, which is the major deposit problem in this service, is viewed with increasing concern because of the very small clearances that exist between certain working parts of recent commercial engine designs.

The introduction of the time factor in determining oil drain periods was mentioned by Ronny Street of Ordnance. He based his suggestion on experience with Army vehicles, where engines with rather short oil drain periods were in worse condition than others with much longer drain periods, in terms of mileage. The trouble with the latter stems from the fact that the time between drains was too long, he added.

In reply, the author said that some advantage might accrue from applying the time factor to light truck operation. For high-speed passenger-car operation, on the other hand, he considers that the mileage basis is adequate.

Antifreeze Contamination of Crankcase Oil—A specific aid in taking care of one possible cause of engine sludge was presented, namely, a test for glycol antifreeze in crankcase oil.

It appears, according to George J. Liddell and Ruth Marshall, Sun Oil Co., that when gaskets leak on an engine using glycol antifreeze, the glycol accumulates in the crankcase because its boiling point is well above crankcase temperatures.

Since it is subjected to the same localized high temperatures and the same oxidizing conditions as the oil, according to the authors, it may very well form resinous materials that can accumulate in critical areas of the engine and cause trouble.

It is thus desirable to detect the coolant leakage on the spot, as early as possible. As an aid in this problem, the Sun engineers have developed a simple, graphic test that can be used in the field to detect glycol in used crankcase oil, in samples of sludge,

and in other deposits taken from internal surfaces of an engine. In fact, they have even developed a compact, portable kit for the use of their own traveling engineers. With the use of this kit the complete test takes less than 20 min.

Several discussers pointed out that this test may give a false indication, under some circumstances. Its greatest usefulness, as H. C. Mougey of GMC put it, is to indicate the probability of glycol in the oil, with the samples thus screened being sent to the lab for confirming tests. D. H. Green, National Carbon Co., said the chemists of his company think that "the theory of resin synthesis from glycol under crankcase conditions is far-fetched."

DIESEL ENGINE

Trend in Engine Bearings and Superchargers Noted

FUTURE outlook is for diesel engines equipped with new types of bearings and more exhaust turbosupercharging, papers at Diesel sessions predicted. What's more, selection of any type of supercharging system may be simplified if techniques suggested are used.

Engineers gathered at one session to hear about the latest developments in engine bearings. Designers, especially, lent attentive ears to descriptions of the advantages of, and applications for, 40% lead copper-lead, silver-gridded slipper, and Moraine-400 bearings.

Forty percent lead copper-lead bearings have definite advantages for use with slow speed diesel or gas engines, they were told. And slipper-type silver gridded bearings have proved their value in subchaser "Pancake" engines, another speaker advised. Moraine-400 has evolved as a bearing with very promising potentialities, a third author added. Tests indicate that when Moraine-400 is used, bearings are no longer a limiting factor in engine design.

The trend is toward more exhaust turbosupercharging of diesels, one engineer pointed out. And, he added, the automotive industry is flirting with the idea of using them.

Recommended techniques for laying out such a supercharging system, as well as a method for selecting the most suitable types and sizes of superchargers to use with a line of engines, also came in for a full share of comment.

All of this information came out of sessions sponsored by the SAE Diesel Engine Activity. Serving as chairmen at these sessions were C. G. A. Rosen and M. M. Roensch.

Describes Uses for High Lead Copper-Lead Bearings

The report that 40% lead copper-lead bearings have definite advantages for use with slow speed diesel or gas engines, came from Albert Willi, Jr. of Federal-Mogul Corp. Experimental tests indicate that these bearings are well suited for use on the unhardened crankshafts used in these engines, he pointed out.

Probably the most striking improvement of this type of bearing over babbitt bearings, Willi noted, is its increased load capacity and fatigue resistance.

Test rig data showed satisfactory performance up to 3000 psi at 1500 rpm, but it is estimated that the limiting load would be set at 2500 psi. However, Willi said, this rating may be expected to change as more experience is gained.

"Fatigue resistance is far superior. No bearing metal breakdown or cracking due to fatigue was observed," Willi continued, "in 13,000 to 17,000 hr. Babbitt bearings in these same engines began fatigue cracking in 5000 to 8000 hr and some approached the danger point at 9000 hr." In answer to a question raised in the discussion, Willi pointed out that the average thickness of these babbitt bearings was approximately 0.015 to 0.020 in.—the conventional lining thickness in the range of engines considered.

To obtain these advantages, he added, conformability, embedability and wear rate suffered somewhat, but this sacrifice has not proved detrimental.

Conformability, enhanced by the application of lead-tin overplate 0.001/0.002 in. thick, appears to be adequate to conform to the usual assembly irregularities and deflections of the slow speed engine. Embedability, also, is judged to be entirely adequate.

Shaft wear with this overplated bearing has been no greater than obtained with the babbitt type. Furthermore, Willi stated, the natural bearing qualities are sufficiently good to give acceptable performance should the overplating be worn off in time.

Manufacturing costs run several times those of babbitt bearings. But, even at their present cost, performance obtained from these 40% lead copper-lead bearings appears to warrant the increased cost, Willi observed.

Slipper-Type Bearings Answer Key Design Problem

Slipper-type silver-gridded bearings proved the answer to a key design problem raised by the 1200 hp diesel "Pancake" sub chaser engine, according to General Motors engineers, A. F. Underwood and A. E. Roach. Use of this type of bearing provided one more way to keep engine weight and size down—a basic requirement in this 16-cyl, vertical-crankshaft radial engine.

Very high bearing loads required the use of a bearing material possessing extremely high fatigue strength, good score resistance, and good embedability—a combination of properties not generally compatible, the authors explained. A silver grid-

type bearing appeared to offer a solution, but a means had to be found to attach it to the slipper end of the connecting rod.

A highly efficient process for bonding a silver pad to the rod was developed, Underwood-Roach reported. This pad was then knurled and the indentations filled with a lead-tin alloy. Diamond boring produced a smooth surface containing a multiplicity of diamond-shaped areas of lead-tin, possessing good embedability and frictional properties —surrounded by an interconnected grid or network of silver, possessing good fatigue strength and load-carrying ability.

The service record of the slipper-type connecting rod with gridded silver bearings has been exceptionally good, the GM engineers went on to say. Nearly 500 "Pancake" engines, using these connecting rods, saw service in sub chasers in World War II, and no complaint was ever received about the performance of the bearings.

Points Out Advantages of Moraine-400 Bearings

Moraine-400 has evolved as a bearing which has very promising potentialities, A. R. Shaw of General Motors revealed.

Bearing life is six to ten times that of conventional babbitt bearings, he stated. Tests showed that where babbitt bearings in a GM medium-duty truck engine run about 100 hr of endurance testing, Moraine-400 bearings will run 750 hr with ease.

Durability and long life of this material, Shaw pointed out, result from a combination of individual properties, such as anti-scoring, fatigue resistance, bond, embedability, conformability, corrosion resistance, and load-carrying ability. Embedability is "phenomenal," conformability "excellent," and corrosion is not a problem, Shaw reported. "Load-carrying ability," he said, "is from four to six times greater than that of the types of babbitt bearings currently used."

To date there have been no failures due to fatiguing or bond failure, this engineer stated, nor from scoring where bearings have been properly designed and installed.

Laboratory tests, conducted on an Olds V-8 engine, indicated that, with Moraine-400, bearings are no longer a limiting factor in engine design, Shaw noted. As long as the shaft is of sufficient diameter to handle the torque taken from it, and the journals long enough to allow for a practical oil hole design, there is sufficient area for adequate bearing life.

Discusser L. D. Thompson noted that Fairbanks-Morse has been using an aluminum-tin alloy bearing in their diesel and dual-fuel engines for a number of years. And these bearings are doing a good job, he said. However, Thompson emphasized, future applications and new engines may require stronger and improved bearing materials.

Predicts More Exhaust Turbosupercharging

The development trend in large is toward more and more exhaust turbosupercharging of modern diesel engines, noted W. T. Von Der Nuell of AiResearch Mfg. Co. "The diesel engine, equipped with this foremost means for further reduction in fuel consumption, for increase in specific output, and for improved torque characteristics," he observed, "will probably long hold its field of usage. . . ."

What's more, Von Der Nuell added, automotive circles have accepted, or apparently are developing, small exhaust turbosuperchargers for Otto cycle engines. These units, consisting of two single-stage radial components—a centrifugal compressor and a centripetal turbine, combine simplicity with good efficiency, which speak for themselves.

Techniques for Choosing Superchargers

An important design consideration in laying out these supercharging systems, Von Der Nuell emphasized, is to make certain that the operating points of the reciprocating engine fall into the range of high efficiency of both radial compressor and turbine, and outside of compressor surging or pulsation. This can be determined, he explained, by superimposing the performance characteristics of the components on a chart and noting whether satisfactory combined operation is possible.

Another extremely useful way to evaluate proposed supercharging systems, Caterpillar's Lloyd Johnson pointed out, is to study the response of an engine to variations in inlet and exhaust conditions.

Not only does this technique facilitate evaluating the potentialities of current engines with any supercharging system, but it also eases the evaluation of possible new engine sizes, Johnson added.

Laboratory tests are made on multicylinder engines, with air-fuel ratio the fixed parameter for each test, he explained. Performance obtained is considered a reasonably practical measure of the usefulness of the engine under the selected intake and exhaust conditions. Mean piston speed, rather than rpm, is used as the measure of velocity, Johnson went on to say, since this facilitates applying tests results to essentially similar engines of different displacements.

"In using such characteristic curves to analyze various engine models," Johnson warned, "one must be aware that certain dissimilarities between engines are likely to exist. Variations in length of jacketed exhaust port, in exhaust manifold shape, and in manifold location can result in variations in percent heat loss from exhaust gases after they leave the cylinder."

These four and several thousand more SAE members and guests stepped up to the registration desks to receive their name cards for the meeting

CALENDAR

Atlanta—Feb. 18

Location undecided; dinner 7: 00 p.m. Meeting 8: 00 p.m. What's in Pneumatic Tire Performance as Advertised—Otto J. Wolfer, tire engineer, Pure Oil Co.

British Columbia—Feb. 11

Hotel Georgia, Vancouver; dinner 6: 30 p.m. Meeting 7: 30 p.m. Meeting to be conducted by Student Section of University of British Columbia.

Buffalo—Feb. 19

Hotel Sheraton; dinner 7: 00 p.m. Meeting 8: 00 p.m. Research—A Partner in Engineering—SAE President D. P. Barnard, Standard Oil Co.

Canada—Feb. 20

Hotel Royal York, Toronto; dinner 6: 30 p.m. Meeting 8: 00 p.m. Ontario's Highways—J. D. Millar, deputy minister, Ontario Department of Highways.

Cincinnati—Feb. 25

Plant visit through Schenley Industries, Inc., plants at Lawrenceburg, Ind. Reservations must be made no later than Feb. 15.

Cleveland—Feb. 11

NACA; dinner 6: 30 p.m. Meeting 7: 30 p.m. Helicopters—Igor Sikorsky. Coffee speaker: SAE President D. P. Barnard.

Detroit—Feb. 18

Rackham Educational Memorial Bldg., small auditorium. Meeting 8: 00 p.m. Subject: Body Stampings Engineering — Die Design — Production. Speakers: A. R. Lindsay, chief automotive engineer, Budd Co.; Russell Cory, die engineer, Fisher Body Division, GMC; A. J. Hole, plant manager, Buffalo Stamping Plant, Ford Motor Co. A colored movie on Problems in Producing Production Stampings will also be shown.

Mid-Michigan—March 10

Flint: 1952 SAE President D. P. Barnard will be guest of Mid-Michigan Section.

Milwaukee—March 7

Milwaukee Athletic Club; dinner 7: 00 p.m. Meeting 8: 00 p.m. Strain Gages in Construction Machinery Design—George Rea, engineer in charge, truck equipment, Heil Co.; Dr. J. H. Meier, research engineer, Bucyrus-Erie Co.

Montreal—Feb. 18

Hotel Mount Royal; dinner 7: 00 p.m. Meeting 8: 00 p.m. Woodlands Mechanization—Bruce J. McColl, mechanical engineer, woodlands section, Canadian Pulp & Paper Association.

New England—Feb. 8

M.I.T. Graduate House; dinner 7:00 p.m. Meeting 8: 00 p.m. Research—A Partner in Engineering—SAE President D. P. Barnard. Coffee Speaker: Harry Stanton, Boston Globe. There will be a cocktail hour.

Northern California—Feb. 27

Engineers Club, San Francisco; dinner 6: 30 p.m. Meeting 7: 30 p.m. Friction and Wear—A. C. West, California Research Corp.

Philadelphia—Feb. 13

Research—A Partner in Engineering—SAE President D. P. Barnard.

St. Louis—Feb. 7

Engineers Club: SAE Past-President Stanwood W. Sparrow will be the speaker of the evening.

Southern California—Feb. 14

Rodger Young Auditorium; dinner 6: 30 p.m. Meeting 8: 00 p.m. The New Ford 6-Cylinder Engine—V. G. Raviolo, engine engineer, Ford Motor Co.

Southern New England—March 5

Hartford Golf Club; dinner 6: 45 p.m. Meeting 8: 00 p.m. Interesting Applications of Roller Bearings—George Wilson, vice-president, engineering, Bower Roller Bearing Co.

Syracuse—Feb. 18

1952 SAE President, D. P. Barnard will speak on Research– A Partner in Engineering.

Texas—March 7

Texas Section will hold Transportation and Maintenance meeting.

Twin City—Feb. 13

Hotel Curtis, Minneapolis; dinner 6:30 p.m.

Virginia—Feb. 28

Hotel William Byrd; dinner 7: 00 p.m. Meeting 8:00 p.m. Speakers have not yet been selected.

Washington—Feb. 19

Joseph Geschelin, Detroit editor of Automotive Industries, will discuss 1952 passenger cars.

Western-Michigan—Feb. 12

Rocket Bar, Grand Rapids; dinner 6: 30 p.m. Meeting 8: 00 p.m. History of the Model No. 567 Diesel Engine—Robert Wellman, senior engineer, Electro-Motive Division, GMC. Cocktail Hour sponsored by Diesel Equipment Division, GMC.

March 3

1952 SAE President D. P. Barnard will speak on Research—A Partner in Engineering.

Williamsport—Feb. 14

Williamsport Airport, dining room; dinner 6: 45 p.m. Meeting 8: 00 p.m. Research—A Partner in Engineering—1952 SAE President D. P. Barnard.

NATIONAL MEETINGS

MEETING	DATE	Hotel
PASSENGER CAR, BODY, and MATERIALS	March 4-6	Sheraton-Cadillac, Detroit
AERONAUTIC, AIRCRAFT ENGINEERING DISPLAY, and TECHNICAL AIR REVIEW	April 21-24	Statler, New York City
SUMMER	June 1-6	Ambassador and Ritz-Carlton, Atlantic City, N. J.
WEST COAST	Aug. 11-13	Fairmont, San Francisco
TRACTOR	Sept. 9-11	Schroeder, Milwaukee
TRANSPORTATION	Oct. 22-24	William Penn, Pittsburgh
DIESEL ENGINE	Oct. 30-31	Chase, St. Louis
FUELS AND LUBRICANTS	Nov. 6-7	The Mayo, Tulsa

SAE National Passenger Car Body & Materials Meeting

March 4-6, 1952 Sheraton-Cadillac Hotel

Tuesday, March 4

9:30 a.m. **Grand Ballroom**
D. F. Caris, Chairman

Symposium—Spark Plug Fouling
Spark Plug Problems in Automotive Service
—**R. C. Beaubier, H. J. Chalk,** and **M. M. Roensch,** Ethyl Corp.
Spark Plug Fouling from a Car Manufacturer's Viewpoint
—**H. N. Metzel,** Oldsmobile Division, GMC
Operation of Spark Plugs in Present-Day Engines
—**H. H. Vogel,** Champion Spark Plug Co.
Spark Plug Fouling Studies
—**R. J. Greenshields,** Shell Oil Co.
Combustion Chamber Deposits and Their Relationship to Power Loss
—**A. E. Cleveland** and **Otto Enoch, Ford Motor Co.**
(Sponsored by Passenger Car Activity)

2:00 p.m. **Grand Ballroom**
W. E. Day, Jr., Chairman

New Applications and Developments in Aluminum Alloys
—**J. H. Dunn** and **E. P. White,** Aluminum Co. of America
New Applications and Developments in Magnesium Alloys in the Automotive Industry
—**J. D. Hanawalt** and **G. K. Glaza,** Dow Chemical Co.
(Sponsored by Engineering Materials Activity)

8:00 p.m. **Grand Ballroom**
A. R. Lindsay, Chairman

Product Drawings as Training Aids
—**A. L. Bradley,** Creative Industries of Detroit
Heating, Ventilating, and Air Conditioning of Automobile Bodies
—**T. C. Gleason,** Chrysler Corp.
(Sponsored by Body Activity)

Wednesday, March 5

9:30 a.m. **Grand Ballroom**
W. H. Graves, Chairman

Panel Discussion—Radiator Material Substitutions
—**J. H. Cooper,** McCord Corp.
—**R. W. Scoville,** Chrysler Corp.
—**Joseph Gurski,** Ford Motor Co.
—**R. J. Birkholz,** International Harvester Co.
—**J. R. Holmes,** Harrison Radiator Division, GMC
(Sponsored by Engineering Materials Activity)

2:00 p.m. **Grand Ballroom**
W. K. Norwick, Chairman

Front-End Sheet Metal Stability
—**L. H. Frailing,** Packard Motor Car Co.
How to Gain Car Rigidity with Convertible Bodies
—**E. L. Allen,** Schonitzer Engineering Co.
To be presented by title:
—Stress Testing Methods in Body Structures
—**H. C. Johnson,** Fisher Body Division, General Motors Corp.
(Sponsored by Body Activity)

8:00 p.m. **Grand Ballroom**
A. T. Colwell, Chairman

New Horizons in Engine Development
—**James C. Zeder,** Chrysler Corp.
(Sponsored by Passenger Car Activity)

Thursday, March 6

9:30 a.m. **Grand Ballroom**
W. J. Lee, Chairman

Passenger-Car Noise—Engine Harshness
—**L. M. Ball,** Chrysler Corp.
Relationship of Tire and Car Engineering
—**E. A. Roberts,** Armstrong Rubber Co.
(Sponsored by Passenger Car Activity)

2:00 p.m. **Grand Ballroom**
E. N. Cole, Chairman

Electronic Simulation as an Aid to the Design of Vehicle Suspension Systems
—**A. Lange and J. C. Dute,** University of Michigan, Willow Run Research Center
Military Torque Converter Transmissions
—**J. E. Storer,** Allison Division, General Motors Corp.
(Sponsored by Passenger Car Activity)

DINNER

6:30 p.m. **Grand Ballroom**

W. H. GRAVES
Chairman, SAE Detroit Section
University of Michigan Men's Glee Club
Directed by Philip A. Duey
ROBERT INSLEY, Toastmaster
D. P. BARNARD, SAE President
"What's with the World?"
GENERAL GEORGE C. KENNEY
United States Air Force (Retired)

About

FRANK E. CARROLL, JR., has been promoted to chief engineer at United Aircraft Products, Inc., Dayton, Ohio. Carroll joined the company in June, 1951, as assistant chief engineer. He was formerly with the powerplant laboratory of Wright Air Development Center in Dayton. Carroll is a member of SAE's aircraft powerplant activity committee.

DR. CHARLES L. THOMAS has joined the research and development staff of Sun Oil Co., Philadelphia, Pa. For the past six years Thomas has been director of research and development for Great Lakes Carbon Corp., and prior to that was associated with Universal Oil Products Co.

ROBERT L. SOMMERVILLE, assistant general manager of Electric Storage Battery Co., has been elected 1952 president of the Association of American Battery Manufacturers. Sommerville joined Electric Storage Battery Co. in 1919 as a salesman at the New York branch office, and has held various sales executive posts since being transferred to the company's main offices in Philadelphia in 1932.

RICHARD D. MAYSTEAD, vice-president of manufacturing of Pacific Airmotive Corp., Burbank, Calif., has also been appointed director of engineering. Maystead started with the company as design engineer, becoming manufacturing division manager in 1948 and vice-president in 1950.

ROBERT G. WINGERTER has been named assistant general manager of the automotive sales division of Timken Roller Bearing Co. He will continue to make his headquarters in Detroit, where he has served as sales engineer for the past seven years. Prior to that, Wingerter was in Timken's application engineering department at the company's main offices in Canton, Ohio.

JACK R. SPLITSTONE has been appointed district manager of the automotive sales division of Timken Roller Bearing Co. in Detroit. Splitstone joined the Canton, Ohio, company in 1937. He was transferred to the automotive division in 1940 and since then has been sales engineer in the Detroit office.

CHARLES D. ADDAMS, vice-president in charge of production of Bearings Co. of America, is on leave of absence to serve as chief of the Bearings Division of the National Production Authority in Washington, D. C. Addams will have charge of allocation of scarce materials used in the manufacture of anti-friction bearings. He has been with Bearings Co. of America since 1921, becoming vice-president in 1937.

EDMUND G. MATHAUER has been named chief engineer of ACF-Brill Motors Co., Philadelphia, Pa. Mathauer was previously assistant chief engineer.

H. HERBERT HUGHES has returned to his post as Washington representative, Studebaker Corp., after two and a half years abroad in charge of strategic materials procurement and production for the office of the special representative of the Economic Cooperation Administration, with headquarters in Paris. Hughes' work had to do chiefly with ECA financial assistance to western European countries to expand production of strategic materials.

J. H. FAMME has been promoted from assistant project engineer to chief project engineer of Consolidated Vultee Aircraft Corp., San Diego, Calif. He succeeds **N. W. BOULEY**, who has been promoted to executive assistant chief engineer. Famme is a past chairman of SAE San Diego Section and has been an active worker in the Section since its start. Bouley has only recently become a member of SAE.

T. K. GREENLEE is now field engineer for Barber-Colman Co. in Los Angeles, Calif. He was formerly chief engineer of the company's controls division in Rockford, Ill. Greenlee is a member of SAE's aircraft air conditioning equipment committee.

Members

HARRY BERNARD and **THEODORE J. ZELLER** have been appointed vice-presidents of Mack Mfg. Corp. Bernard, who becomes vice-president in charge of service, has been with the company since 1924 and has been chief engineer for the past four years. He will make his headquarters at the Plainfield, N. J., plant. Zeller becomes vice-president and chief engineer, and will remain at Mack's plant in Allentown, Pa. He has been factory manager of that plant since 1948, having joined Mack in 1926.

JOHN B. HULSE has been named president of the Washington Trade Association Executives, the professional organization of trade association managers in Washington, D. C. Hulse is managing director of the Truck-Trailer Manufacturers Association. He is the present vice-chairman of SAE Washington Section.

JAMES W. SCHIEFER has been named supervisor of product planning for Lincoln-Mercury Division of Ford Motor Co. Schiefer was formerly executive vice-president of Technical Managers, Inc., in New York City.

PHILIP D. DORAN has been promoted to chief of commercial sales at Pratt & Whitney Aircraft, East Hartford, Conn. He has been with Pratt & Whitney since 1929, most recently as chief of airlines engineering, a department he was largely responsible for establishing.

EDWARD D. MEEKER has assumed the duties of general sales manager for Wheels, Inc., transferring his headquarters to New York City. Meeker has been with Wheels for 20 years, and for the past five years has been manager of the Newark branch. In his new capacity he directs sales, merchandising, and service educational effort in all branches.

JOHN W. MEADER, who was economist for Great Lakes Carbon Corp., New York City, has been elected assistant vice-president of the corporation.

WILLIAM E. RIGLEY is now assistant chief engineer, chassis department, of Dodge Truck Division of Chrysler Corp., Highland Park, Mich. He was previously assistant chief resident engineer at the Dodge Truck Plant in Detroit.

HENRY P. GRONE is now service manager of Colliers, Ltd., in Vancouver, B. C. Grone formerly held the same position with Ross Baker Motors in Vancouver.

EDWARD J. BEHNEY is assistant chief engineer for Electric Boat Co., Groton, Conn. He had been chief engineer of the company's Elco Naval Division in Bayonne, N. J.

HOWARD A. TUBBS is now vice-president and plant manger of Whitewater Pump Co., Whitewater, Wis., which has taken over the activities and patents of his firm, Tubbs-Craft Engineering.

KENNETH C. SMITH is now motor vehicle supervisor, central division, Richfield Oil Corp., in Oakland, Calif. Smith was formerly with General Petroleum Corp. in Los Angeles.

HARRY O. MATHEWS is now general manager of transportation and distribution of Armour and Co., Chicago. He was previously manager of transportation for Standard Brands, Inc., and during World War II served as a colonel with the Ordnance Department. Mathews was SAE vice-president representing transportation and maintenance activity in 1939.

T. H. MORRELL is now chief engineer at the Charles City, Iowa, plant of Oliver Corp. Morrell, who was formerly assistant chief engineer and has been with Oliver since 1944, succeeds **L. A. GILMER**, who died suddenly last September.

PETER Y. BURNS is now assistant chief engineer of Oliver Corp. at the Charles City, Iowa, plant. Burns was formerly supervisor of experimental engineering. He succeeds **T. H. MORRELL** (see above), who has been advanced to chief engineer.

Cleveland Graphite Bronze Co. Promotions

Robert E. Mooney

Wilmer D. Cowgill

Starr W. Pearn

Three SAE members in the sales department of Cleveland Graphite Bronze Co., Cleveland, Ohio, have been promoted. **ROBERT E. MOONEY**, who has been district sales manager at the company's Detroit office since 1948, returns to Cleveland to be district sales manager for the Ohio territory, and will also handle special assignments for the sales division. He is succeeded as Detroit sales manager by **WILMER D. COWGILL**, who has been Detroit sales representative since 1939. **STARR W. PEARN**, a member of the engineering division field service staff, moves to Detroit to become sales representative there.

ARTHUR W. BULL has been elected vice-president in charge of engineering of Michigan Wire Cloth Co., Detroit. Bull has been chief engineer of the company since 1947. Previously he was project engineer at King-Seeley Corp.

ALBERT B. SAXMAN has joined the merchandising department of Sun Oil Co., Philadelphia, Pa., as special assistant. He was formerly technical editor of The American Automobile magazine, McGraw-Hill International Corp., New York.

WILLIAM J. JOYCE, JR., has been appointed to the newly-created post of liaison engineer of Dana Corp., Toledo, Ohio. He comes to Dana from the Wayne Pump Co., where he was research director. Prior to that Joyce was chief engineer for Raybestos-Manhattan, Inc., at Manheim, Pa.

JOHN WALDHERR, JR., has been named director of engineering of Chefford Master Mfg. Co., Fairfield, Ill. Waldherr joined the company in 1947 and has served as chief design engineer since 1949. In his new post, he will direct all engineering activities related to the company's automotive products and ordnance contracts.

KENNETH D. ROBERTS is now sales engineer for Bendix Westinghouse Automotive Air Brake Co. at the company's Detroit office. Roberts was formerly test engineer for Bendix in Elyria, Ohio.

JOHN H. CLAREY, who was owner of Clarey Motors, Santa Barbara, Calif., has joined Douglas Aircraft Co., Inc., El Segundo, Calif., as service representative for the southeastern territory.

H. L. ZIMMERMAN, who was associated with the Fulton Co., Milwaukee, Wis., is now an independent consultant in that city.

DR. THEODORE P. WRIGHT, vice-president for research of Cornell University, is chairman of the new Cornell Committee for Transportation Safety Research. The Committee, which has grown out of the Cornell Committee for Air Safety Research, will conduct research aimed at increasing accident survival on the highways as well as in the air. Immediate efforts will go into the improvement of basic car design, though later work may extend to highway engineering and other elements of accident prevention. **JEROME LEDERER**, director of the Guggenheim Aviation Safety Center at Cornell, will be a member of the new Committee. The new committee will work in cooperation with the Guggenheim Center and other medical and engineering research projects.

The theoretical aspects of carburetion are emphasized in Vol. 1 of the new third edition of "Carburation," by **CHARLES H. FISHER.** This volume, entitled "Applied Carburation and Petrol Injection," includes new chapters on detonation, the carburetion of heavy tractor fuels, and fuel injection in aircraft operation. The book contains 356 pp., 178 illustrations, and is published by Chapman & Hall, Ltd., London.

STUART NIXON was a member of a panel discussing "The Effect of Lubricating Oil upon Diesel and Gas Engine Performance" at the annual meeting of American Society of Mechanical Engineers in Atlantic City.

L. M. DARTS has joined the rubber division of Ball Brothers Co., Muncie, Ind., as Detroit representative. He was formerly sales engineer for Firestone Tire and Rubber Co. in Noblesville, Ind.

LOUIS G. KAPLAN, who was project engineer for International Harvester Co., is now research engineer at Armour Research Foundation in Chicago. His work is in the heat power division of the Foundation.

KENNETH C. MAGISTRATE, who was project director for S. F. Chamberlain Co., is now a technical writer for Technographic Publications, New York City.

JUDSON A. PURVIS, technical editor of Motor Service magazine, is the author of "Brakes and Steering," a new auto mechanics manual published by Goodheart-Willcox Co., Inc., Chicago. The manual covers all systems used on American passenger cars and trucks, and makes extensive use of illustrations to explain operational principles.

L. L. COLBERT, president of Chrysler Corp., was dinner speaker at the annual meeting of the Automotive & Aviation Parts Manufacturers, Jan. 30, in Detroit.

ROBERT S. SCHUYLER has been promoted to regional truck manager for Dodge Division of Chrysler Corp. in the Chicago region. Schuyler was formerly zone truck manager.

HARVEY S. FIRESTONE, JR., chairman of Firestone Tire and Rubber Co., will be co-chairman of the Religious Organizations Committee for Brotherhood Week, which is to be observed throughout the nation Feb. 17 to 24.

"Servicing Guide to British Motor Vehicles" is a new reference manual on British cars, commercial vehicles, and tractors by **J. N. McHATTIE.** It contains 52 service data sheets on these vehicles. Each model is dealt with on a standardized plan, with sectional arrangement drawings, diagrams, sketches, and tabulated data. Details of servicing operations, stressing unusual features of design, are given. The volume also has a list of alternate parts names, British and American, and tables giving conversions among British, Continental, and American units. Publisher is Trader Publishing Co., Ltd., London.

ELMER F. DeTIERE, JR., formerly plant and equipment engineer for Northwest Airlines in St. Paul, is now plant layout engineer with A. O. Smith Corp. in Rochester, N. Y.

THEODORE J. MATEGORIN has joined Hughes Aircraft Co., Culver City, Calif., as a product engineer. He was previously a senior engineer in the research laboratory of Bendix Aviation Corp. in Detroit.

THOMAS H. TERRY has joined Raybestos-Manhattan, Inc., Cleveland, Ohio, as sales engineer. Terry was previously with Bendix-Westinghouse in Detroit.

EDWARD F. PETRELEWICZ, who was a test engineer at Detroit Arsenal, Centerline, Mich., has joined International Harvester Co., Chicago, as product tester in the industrial power engineering and development test laboratory.

JOSEPH A. POLSON, formerly professor at the University of Illinois, is at present lecturing on mechanical engineering at the University of Florida.

RICHARD L. PIERCE is now with Nash Motors in Detroit. Pierce was previously layout and design draftsman for Thompson Products, Inc.

Changes at General Motors Research Laboratories

Alfred L. Boegehold

E. V. Rippingille, Sr.

Robert F. Thomson

Cleveland F. Nixon

William M. Phillips

Three major administrative changes in General Motors Research Laboratories have been announced by **CHARLES L. McCUEN**, General Motors vice-president and general manager of the Research Laboratories Division. **ALFRED L. BOEGEHOLD**, former head of the metallurgy department, becomes assistant to the general manager.

He suceeds **E. V. RIPPINGILLE, SR.**, who has retired but will continue in a consulting capacity. Rippingille was born and educated in England, and joined the Research Laboratories staff in 1932 as business manager. He was named assistant to the general manager in 1937.

DR. ROBERT F. THOMSON will succeed Boegehold as head of the metallurgy department. Thomson came to the Research Laboratories in 1950 as an assistant to Boegehold. He was formerly with International Nickel Co.

CLEVELAND F. NIXON, director of process development for GM's Ternstedt Division, has been appointed head of the Research Laboratories electro-chemistry department. Prior to joining Ternstedt Division as a plating engineer in 1929, Nixon was with the Western Electric Clock Co.

Nixon succeeds **WILLIAM M. PHILLIPS**, who will continue on the Research Laboratories executive staff until his retirement in September. Phillips came to General Motors in 1921 as an advisor on plating, painting, and enameling in production engineering.

ELLIOT SCHILLER has joined Republic Aviation Corp., Farmingdale, N. Y., as a thermodynamic engineer. Schiller was previously propulsion engineer for Glenn L. Martin Co. in Baltimore.

GEORGE T. WILSON has been promoted to group engineer on wing and nacelle structural components for Douglas Aircraft, Inc., Long Beach, Calif. Wilson was previously design engineer for the company.

MAJ. TOM R. TOMPKINS is now with the U. S. Air Force stationed at Wright Air Development Center, Dayton, Ohio. Major Tompkins was formerly with Oldsmobile Division of General Motors Corp.

ERLING D. SEDERGREN has been appointed general manager of Roy S. Sanford and Co., Oakville, Conn. Prior to joining the company 2 years ago, Sedergren was manager of the affiliate department of United Shoe Machinery Corp. in Boston, Mass.

CHARLES E. COONEY, JR., has completed service as a lieutenant in the U. S. Navy, and has joined Studebaker Corp. in South Bend, Ind., as experimental engineer.

JOHN P. DRANEK is now an inspector of engineering and materials for the Army's Corps of Engineers in Kansas City, Mo. Dranek was previously tool sales engineer for W. E. Fry and Co., Kansas City.

ALBERT L. PRESTON is now research engineer for American District Steam Co. in North Tonawanda, N. Y. Preston was previously associated with Frederic Flader, Inc., of North Tonawanda.

ARTHUR J. CLARK, JR., is now staff engineer with Sandia Corp., Albuquerque, N. M. Clark was formerly structures engineer with the propeller division of Curtiss-Wright Corp., Caldwell, N. J.

WILLIAM DEIN LEWIS is now in the mechanical improvement group of the engineering department of E. I. du Pont de Nemours and Co., Inc., in Wilmington, Del. He was previously with Ingersoll Rand Co.

Obituaries

GEORGE W. DAVIES

George W. Davies died at his home in Muskegon, Mich., on Dec. 3 at the age of 62. He had been ill for more than ten months.

Until recently, Davies had been general sales manager of Sealed Power Corp. He joined the company in 1933 as manager of the Detroit office, moving to Muskegon in 1941 when he became sales manager of Sealed Power's Original Equipment Piston Ring Division. He was named general sales manager in 1948.

Davies was born in London, but moved with his parents to Swansea, Wales, when he was eight. He came to America in 1912, and a year later took a post in Peru for South American Development Co. In 1911 he joined Montgomery Ward and Co. in Chicago, and later was with Campbell, Wyant, and Cannon Foundry Co. and Fitzjohn Mfg. Co. in Muskegon.

He is survived by his wife, whom he married in Swansea in 1908, a daughter and a son, and two grandchildren.

RUSSELL A. FIRESTONE

Russell A. Firestone, a director of Firestone Tire and Rubber Co., died Dec. 12 in New York after a long illness. He was 50.

Firestone, who was the second son of Harvey S. Firestone, was born in Akron, Ohio, and attended Phillips Exeter Academy and Princeton University. He joined Firestone Tire and Rubber after graduating from Princeton in 1924.

In 1932 he was made a director of the company and became general manager of the mechanical rubber goods division. Firestone was appointed general manager of the Nebraska Defense Corp., a Firestone subsidiary, at the outbreak of World War II, and supervised construction of the company's bomb-loading plant near Omaha. In 1943 he was elected assistant treasurer of the parent company.

Firestone took an active interest in the National 4-H Club, the Future Farmers of America, and other youth organizations. He was senior warden of St. Paul's Episcopal Church in Akron.

He was a breeder of thoroughbred horses and a member of several racing associations.

Firestone is survived by his wife and two sons, as well as by his mother and four brothers.

WALTER A. KULL

Walter A. Kull died Dec. 29 at his home near Bridgeport, Mich. He was 60 years old.

Kull entered the automotive industry as a draftsman for GMC Buick Motor Car Co. After two years with Buick he spent several years as assistant chief engineer with Argo Electric, but in 1914 returned to Buick as tool and product designer. During World War I he served with the air arm of the Signal Corps, and at the end of the war was aeronautical engineer in charge of development of plane surfaces. Kull returned to Buick as chassis engineer, and played an important part in the development of four-wheel brakes and the disc-type clutch.

In 1924 he was transferred to General Motors' Saginaw Steering Gear Division. He was named division chief engineer in 1928 and divisional sales manager in 1935. In 1938 he became the division's general sales and service manager. Kull left General Motors in 1945 and became a partner in McKenna Sales Co. of Detroit.

In addition to serving on the governing board of Detroit Section, Kull was a Mason and a member of the Saginaw Club, the Germania and the Detroit Athletic Club. He is survived by his wife, stepson, and brother.

JOHN S. PELAN

John S. Pelan, electrical engineer with Mack Mfg. Co. in Plainfield, N. J., died Dec. 30 at the age of 57.

Pelan joined Mack in 1919 after serving as a first lieutenant in the Signal Corps during World War I. He graduated from Wentworth Institute of Boston in 1915 in electrical engineering, and later studied motor vehicle design and motor testing at Cooper Union in New York. From 1915 to 1917 he was with Boston Edison Co.

Pelan was a member of the American Legion and the Last Man's Club as well as of SAE.

GEORGE C. CARHART

George C. Carhart, 81, died suddenly on Jan. 1 while watching the Pasadena Rose Parade. Since his retirement from General Motors Corp. in 1945, Carhart had lived in San Gabriel, Calif.

Carhart first joined General Motors in 1928 as transmission and clutch engineer for Buick Motor Co. After several years with Buick he joined GMC's Truck and Coach Division to develop the automatic transmission for its line of busses.

From 1937 to 1940, Carhart was in charge of all gearing for General Motors Overseas Corp. at the Opel plant in Weisbaden, Germany. During World War II he was associated with the Detroit Diesel Engine Division.

Carhart was born in Collamer, N. Y., and grew up in the area of Syracuse. He graduated from Syracuse University with a degree in electrical engineering in 1903, and entered industry with the H. H. Franklin Mfg. Co. From 1906 to 1928 he was chief engineer of W. C. Lipe, Inc., and Brown-Lipe Gear Co. of Syracuse.

Carhart had been a member of SAE since 1917. He is survived by his wife, son, and a granddaughter.

SAE Section Meetings

Engineer's Role Vital In Defense, Roeder Says

• Pittsburgh Section

R. L. Sailer, Field Editor

Nov. 27—The November meeting of the Pittsburgh Section marked the official visit of **Dale Roeder** to the Section. Pittsburgh was further honored by the presence of Mrs. Roeder and of **John A. C. Warner**, secretary and general manager of SAE.

The meeting was conducted by Pittsburgh Section Chairman W. J. Kittredge, Jr. John Warner was presented, and after reminiscing on his early visits to Pittsburgh at the time of the organization of the section, took advantage of the opportunity to acknowledge the debt of gratitude which the SAE owes Mrs. Roeder and to thank her for her cooperation with the extensive demands made on her husband in his activities as SAE president.

Kittredge then paid tribute to the fine work being done by the SAE Student Clubs at Carnegie Institute of Technology and the University of Pittsburgh and introduced Joseph M. Steiner, chairman of SAE at the University of Pittsburgh and G.S. Austin, chairman of SAE at Carnegie.

The main event of the meeting was the timely talk of SAE President Dale Roeder on the subject "The Engineer's Part in Today's Crisis." He addressed his talk partly to the students present, making the point that the prosperity and strength of our country depends on technological development and that the engineer of today and the future holds a position of importance. Two wars have stimulated the growth of the profession in the twentieth century and today we face the problem of carrying on peactime activities and defense work at one time.

Roeder described the activities of the SAE in World War II, which he stated was an automotive engineering war. SAE has maintained liaison with the military since the war and was ready at the start of the Korean war. In this period of limited war and peace the SAE military activity is the greatest in history with some 500 members on technical committees cooperating with the military.

Committee activities include work on critical materials and the recommendations of 2 and 3 alternates on some 700 parts, studies on transmissions, development of sealed lights for night construction, studies on sealed brakes, engine cooling, investigation of vehicles and earthmoving equipment, the use of boron in steels, among other activities. With nickel and molybdenum in short supply, the investigation of boron before the pinch by SAE places the automotive industry six months ahead in steel study, said Roeder. The Air Force particularly is grateful for the work of SAE and while there was time in World War II to develop engineering, there may not be enough time in the future war.

Roeder pointed out that the engineer will shoulder the major part of another war; expanding civilian economy along with defense activities will also depend on the engineer. These problems must be answered by the development of new materials to replace those in short supply, including new fuels. Investigation is now being conducted on the sun as a direct source of energy. Roeder closed by saying that SAE will play an important part in the working out of these problems, and young engineers will find discussions with experienced men, a broadening of view points through common interests, familiarization with existing standards, and stimulation of new ideas available through membership in SAE.

Magnaflux Process Is Topic at Salt Lake

• Salt Lake Group

J. Percy Bywater, Field Editor

Nov. 26—The Magnaflux method of inspecting for minute discontinuities in magnetic metals was described in some detail at this meeting by **Robert G. Strother**, West Coast manager, Magnaflux Corp. It depends, he explained, on the interruption of a magnetic field to detect flaws, rather than on visual or mechanical means. By flowing over the metal surface a finely divided dispersion of magnetic particles, either wet or dry, the interruption of the magnetic flux through the part causes particles to be attracted to cracks, laps, or discontinuities in the metal.

Salvage often is possible, he said, even when tell-tale cracks are discovered.

Salt Lake Group Chairman Stanley W. Stephens presided at the meeting. Strother used a motion picture as well as numerous slides to make his description interesting and understandable.

Medical Problems Of High Altitude Flight

• Southern California Section

Peter Kyropoulos, Field Editor

Nov. 8—The effects of high altitudes on the human body was the subject of a paper by **Dr. C. I. Barron** presented at the monthly meeting of Southern California Section.

Normally the average man can tolerate pressure altitudes of up to 10,000 ft in safety and without undue discomfort, Barron said. Above 10,000 ft, the effect of lack of oxygen will be felt: first effects are often a feeling of exhilaration and loss of inhibitions resembling those produced by alcohol. Death rarely occurs at altitudes below 15,000 ft.

Hypoxia, or an inadequate intake of oxygen, is especially insidious in that unconsciousness may ensue before the subject is aware even of the first effects. It has never been determined, how many airmen lost their lives during World War II as a result of hypoxia, but the figure runs well into the hundreds and probably thousands, Barron said.

Up to 10,000 ft, flight is safe and comfortable without supplementary

At the Nov. 27 meeting of Pittsburgh Section, Chairman W. J. Kittredge, Jr., talks to President Dale Roeder, who spoke to the group on the engineer's role in the present national situation

You'll Be Interested to Know . . .

NEW SAE STUDENT BRANCHES have been authorized at Chrysler Institute of Engineering and Bradley University. The Club from which the Chrysler Branch was formed has attracted some 60 members in its two years of functioning. The Bradley SAE Club—also in action for two years—becomes a branch with about 80 members.

BY-LAW 38 HAS BEEN CHANGED to remove the top limit of 16 members for Professional Activity Committees. It now reads in part that "Professional Activity Committees shall consist of not less than 12 voting members, including the chairman." . . . As in the past, the chairman may designate non-voting members as consultants.

REAPPOINTMENTS: H. K. Cummings, Bureau of Standards, has been reappointed for a three-year term beginning Jan. 1, 1952, as SAE representative to the American Documentation Institute . . . and Herbert Happersberg, Brockway Motor Co., has again been named SAE representative at the Annual Convention and Exposition of the Greater New York Safety Council. The 1952 Convention will be April 1 to 4 at the Hotels Statler and New Yoker, New York City.

oxygen. Flights up to 40,000 ft can be made safe by adding oxygen to the inspired air in gradually increasing percentages. By supplying 100% oxygen, to the complete exclusion of nitrogen, the oxygen pressure in the lungs at sea level can be simulated. A supply of 100% oxygen at 40,000 ft is in effect an atmospheric 10,000 ft oxygen equivalent, and is the maximum safe level of ascent for prolonged flights without pressurization.

To maintain safe oxygen conditions at 50,000 ft, it would be necessary to breathe 100% oxygen supplied with an increased pressure of 54 mm of mercury. Unless counter-pressure is applied to the body, this cannot be done without damage to the lungs and circulatory system.

While it is impossible for the body to withstand breathing pressure in excess of 50 mm, it can tolerate these pressures if sufficient counter-pressure is applied, especially to the chest wall. This is the principle behind the pressurized vest, the full pressure suit, and the partial pressure suit. The chief objections to the pressure suit are the discomfort of wearing it and the fatiguing effect on the breathing muscles. The practical advantage is its availability for emergency use, to enable its wearer to descend to safe altitudes should cabin pressurization fail.

While cabin pressurization is at present the sole practical means of sustained flights above 50,000 ft, it has the major disadvantage that sudden depressurization, such as the penetration of a bullet or a meteorite, or the loss of a window, would immediately expose the occupants to conditions at the actual altitude of the plane. At 40,000 ft, death would occur within 3 to 5 minutes.

Freezing and Gas Expansion Are Dangers

Exposure to cold of various degrees may be anticipated up to 35,000 ft; above that altitude, a relatively constant temperature of −55 deg C is expected. If it is necessary to escape from a plane at this temperature, a safe period of about 60 sec ensues before normal human tissue freezes.

Another hazard of explosive decompression is the unlimited expansion of gases in the body cavities, such as those in the lungs, intestinal tract, and ear, and the formation of gas bubbles in the tissues. In military aircraft flying at high altitudes, pressure suits are worn even in pressurized cabins as a precautionary measure. The suit must be inflated almost immediately after decompression of the cabin, Barron said.

In summary, Barron said that the flights up to 40,000 ft can safely be accomplished with the use of supplementary oxygen. Flights up to 50,000 ft are possible for short periods if pressure breathing equipment is used. Prolonged flights up to 70,000 ft are feasible in pressurized aircraft, but flights above that altitude probably should not be undertaken until we have more knowledge of the effects of cosmic radiation.

Discusses Basic Types Of Truck Diesel Engines

• Texas Section

A. P. Johnston, Field Editor

The merits of various types of truck diesel engines were discussed by **Tom Collins** at the November meeting of Texas section. Collins, who now holds the Kenworth dealership for Texas, Oklahoma, Arkansas, and Lousisiana, has worked with diesels since 1924 with White Motor Co., Cummins Engine Co., the diesel engine division of Buda Co., and Pacific Freight Lines.

Collins pointed out that the basic difference in U. S. truck diesels resolves itself between two types of fuel systems, one the hydraulic (Bosch) system, the other the mechanical (Cummins) system.

Fuel line dilation in the hydraulic system has long plagued engine builders. Pressure waves built up in the fuel line give varying pressures at different points of the fuel line. Adjusting the fuel line length to give maximum pressure at the injector becomes the logical answer, but temperature changes cause changes in the length of the fuel line. This changing injector pressure causes a change in injection timing resulting in power losses of up to 8%.

In the hydraulic system, fuel injection is relatively fast and occurs during approximately 3 deg of crankshaft travel. This fast injection makes fuel burning rate an important item, with the resulting cetane rating being put on diesel fuels.

In the Cummins mechanical system, fuel injection is done by individual cylinder injectors over a period of 40 deg of crankshaft travel. This longer injection time causes a slower rate of burning and a resulting higher bmep for the engine, but lower maximum cylinder pressures.

Kaiser Urges Expanded Economy

• Dayton Section

W. D. Hazlett, Field Editor

Nov. 28—**Edgar F. Kaiser**, president of Kaiser-Frazer Corp., spoke on "Conversion—A Continuing Policy."

The dual-purpose plant—one that can quickly be converted from peacetime production to war materials—offers certain advantages over the construction of new facilities for defense production in speed and economy of conversion, said Kaiser. But more of the cost of converting a dual-purpose plant is borne by industry and less by the government than in the case of

building a new plant. Furthermore, Kaiser disagrees with the principle of the dual plant on the grounds that it implies an either-or economy, rather than an expanding one.

"The whole basis of dual-purpose plants is a belief that we, as a nation, cannot sustain a full economy in civilian production, as well as doing an adequate job defense-wise. It presupposes that we must drop the level of civilian production in order to accept our defense requirements. It is a philosophy of shortages and compromises," said Kaiser.

Short of total war, we must carry a full program of civilian production along with our defense production. In the discussion that followed the paper, Kaiser emphasized that there is no need for our current shortages of material. As an example, he said that our aluminum industry is still a baby industry. The present cost of packaging aluminum is 9¢ per pound. This can only be reduced by increased production, he said, and added that less regulation on our banks would produce the needed funds. More latitude in regard to risk capital is needed for expansion of our economy, he concluded.

Clear Writing For Easy Reading

• Philadelphia Section

M. A. Hutelmyer

Jan. 9—"Clear writing follows from clear thinking," **Norman G. Shidle**, SAE Publication Division manager, told a meeting attended by more than 125, including many students.

Dale Kelly, student chairman of Philadelphia Section, was technical chairman for the evening. Section Chairman Linn Edsall opened the meeting.

The aim of everyday writing is not only to get ideas on the page, but to get them off it into the reader's mind, Shidle continued, quoting from his recently published book, "Clear Writing for Easy Reading."

Effective writing must start in the writer's mind, before he sets down a single word. Once the writer knows what he wants to say, why he wants to say it, and whom he's saying it to, clear writing should follow automatically.

This "prethinking" should lead to the "peg" idea—the one main idea the writer wants to get across. All the other ideas in the piece of writing will hang on this peg; if they don't, then they belong in another piece, not this one. An everyday writer can hope to get only one idea, or at most a few, into his reader's mind.

If it seems impossible to arrive at a simple peg idea, probably the writer hasn't done enough thinking. The man who "knows what he wants to say but can't put it into words" is fooling himself; he just doesn't know what he wants to say.

This peg goes into the first sentence of the letter, memo, or report. The lead sentence should be a direct, positive statement, not weighted down with qualifications or details.

Everyday writing gets the idea across in the lead sentence—doesn't try for suspense or surprise. Shidle gave 3 reasons for this:

1. If the reader gets no further than the first sentence, he has the main idea the writer wanted him to get.

2. An irrelevant opening may get the reader's attention, but it won't hold it when the real subject appears. The bathing-beauty approach to advertising axles may get attention, but not for the axle manufacturer. "Your lead sentence is your shop window," said Shidle. "Be sure you fill it with the merchandise you really want to sell."

3. A good lead prepares the reader's mind for what follows—leads him to expect the direction the piece will move in, and helps him grasp it quickly.

"Sentences that march" was Shidle's description of writing that carries the idea forward firmly. "If sentences shuffle along, the reader gives up in boredom. If they dart first one way, then change direction and start off again, he gives up in exhaustion."

Chief fault of many engineers is "overweight" writing. In an effort to be exact they clutter writing with "fat" words and phrases that might have been left out or replaced by a short word. Long words are good only if no shorter word would do the job. Technical terms can be useful shorthand, but only if (a) the reader understands them, and (b) they really are shorthand. "Thermal equilibrium" isn't good shorthand for "even temperature."

Hobart Plant Host To Dayton Meeting

• Dayton Section

W. D. Hazlett, Field Editor

Dec. 12—Dayton Section members saw the manufacture of welding equipment, engine-generator units, jet engines starters and battery chargers when they visited Hobart Brothers Troy, Ohio, plant today. Ninety percent of Hobart production centers in this plant. A feature of the inspection trip was seeing the welding school which Hobart operates here.

Hobart was host to the Section at dinner prior to the plant tour—and at a professional ice hockey game at Hobart Arena following the tour.

Gives Service Data for Crawler Tractor Use

• Hawaiian Section

F. C. Leensvaart, Field Editor

Nov. 19—**Ward Deffenbauch**, industrial sales and service engineer, International Harvester Co., Chicago, gave a wealth of preventive maintenance and service information about crawler tractors at this meeting. A great deal of such equipment is used in the Hawaiian Islands, where sugar and pineapples are major industries.

In the question and answer session which followed, Deffenbauch had the assistance of Irvin Strand, from IHC's Oakland, Calif., office. Several problems encountered on the various plantations were discussed. Action to be taken by the operator as well as corrective action by the manufacturer was suggested.

Hawaiian Section's October meeting was held on Oct. 15 at the Pearl Harbor Naval Base. The members at dinner made a spectacular group, clad in bright "Aloha" shirts. In the tour that preceded the dinner, members inspected the guppy-snorkel type submarine "Greenfish." Eighty were present

SAE Student News

Cal-Aero Technical Institute

The November meeting of the SAE Student Branch at Cal-Aero was held on the 14th. Chairman Charles Stauffer introduced the guest speaker, Al Gorenbein, of Bendix West Coast Division, who gave a short talk on low tension ignition systems.

On Dec. 12 David Moseley, head of the stress analysis group at Douglas Aircraft Co. at Long Beach, Calif., addressed the group on stress analysis problems of large multi-engined aircraft. Election of new officers for the Student Branch was scheduled for the first week in January, and plans were made for a field trip to Standard Oil Co. at El Segundo on Jan. 16.

—J. G. Ruede

University of Oklahoma

The Student Branch at the University of Oklahoma sponsored the first sports car meeting in the history of the University of Oklahoma on Nov. 9.

Approximately five hundred turned out for the meeting which was the largest number to turn out for any event held so far by the Engineering College this year. Dean W. H. Carson, Dean of the College of Engineering, and approximately forty-five members of the Oklahoma Society for Professional Engineers attended the meeting. Many members of the Mid-Continent Section of the SAE also were there.

The meeting was opened in the auditorium of the Engineering building by Chairman Tom McDuffie with a brief explanation of the background for the meeting. Two movies were then shown, one of them being on the Alpine races in Europe and the other on the factory testing and road testing of the Morris Minor. From these movies it was conclusively shown that the British put their cars through a much more rigorous testing than most American automobile manufacturers. After these movies the meeting was adjourned to the mechanical engineering laboratory where the sport cars were on display.

These cars, ten in all, were furnished through the courtesy of the Thoroughbred Motor Company in Oklahoma City and the Oklahoma Chapter of the Sports Car Club of America. The drivers of the cars answered the many questions asked by the group.

Among the cars which were exhibited was the famous Jaguar XK-120, the fastest stock car in the world, and a German Porche, a Crosley Super Sport, a Hecker Special, two different Morris cars, and four MG's. One of the MG cars had a super charger installed in it which enables the car to travel 100 mph easily.

On Dec. 13, the SAE Student Branch held a joint meeting with ASME. Guest speaker was Landrum Hughes of Oklahoma City, who spoke on "Propane and Butane Conversion for Aircraft and Automobiles."

Hughes mentioned the relative ease with which a conversion unit may be installed in automobiles. The unit, which costs around $300, has many advantages over the use of gasoline. First, it prolongs the engine life of the car about four times as long as if gasoline were used; secondly, it has a more even force on the piston during combustion than gasoline; thirdly, butane and propane cost much less than gasoline. The unit is equipped with an electrical switch by which one may switch to gasoline instead of butane or propane.

In connection with the engine life, Hughes said that they had a 1941 six cylinder Chrysler which had a little over 427,000 miles and had not yet been overhauled.

Butane and propane have several advantages in the aircraft industry over gasoline. First, they weigh considerably less than gasoline, and secondly, there is never any carburetor icing as there is with the use of gasoline.

After the talk Hughes answered many questions from the floor and showed the conversion unit on a 1949 Chevrolet.

—Dan Toner

B. W. Bogan, chief engineer of Dodge Division, Chrysler Corp., addresses a group of mechanical engineering students from Illinois Institute of Technology at breakfast at Hotel Fort Shelby in Detroit on Dec. 14. The breakfast preceded a day of Detroit plant tours for the students from Chicago

Detroit Institute of Technology

The Detroit Institute Student Branch produced a radio symposium on the topic of the current shortage of engineers as the Dec. 15 program of "What's Your Opinion," a series of broadcasts planned by Detroit Tech and heard over Station WJLB, Detroit.

Participating were George Payne, Walter Szczypinski, Donald West, and Russell Jenness of the Student Branch. The discussion emphasized that while some students will always pick the field of engineering, current inducements to the college-trained engineer are probably not sufficient to attract those considering several fields to choose engineering. The four years spent in college should be regarded as four years of apprenticeship for the skilled laborer, said Szczypinski, while actually graduate engineers are offered lower salaries than skilled workers.

Professor L. L. Henry, faculty advisor of the Student Branch, spoke of the need for a single engineering so-

ciety to establish standards as to who may call himself a professional engineer. He urged all engineering graduates to take state board examinations for professional registration, and to join an engineering society which will work for the professional recognition of engineers.

—Donald J. West

College of the City of New York

The SAE Student Branch at the College of the City of New York was fortunate in having as one of its recent speakers **W. J. Quigley** of the Ethyl Corp., who presented a paper on the industrial advances in high compression engines.

In studying high compression engines one has to immediately consider the type fuel used. There are four types of gasolines produced from base crude oils that are in use today. These are: straight run, thermally cracked, catalytically cracked, and polymer gasolines. The last three of the beforementioned impart to the gasoline such qualities as to render them more useful for obtaining greater efficiency in high compression engines.

Quigley showed movies relating to the fuels used. The second film showed the actual combustion process in the combustion chamber of the cylinder, and the effect of high and low octane number gasoline upon knocking. The actual combustion process and the travel of the flame front were seen in slow motion as it was photographed by a special camera designed for that purpose.

He then showed a series of slides which dealt primarily with the comparison of performance characteristics of auto engines from 1931 to 1951. Such characteristics as horsepower, miles per gallon, acceleration, and so forth, were shown for the years 1931 to 1951. The use of high octane gasoline and the consequent gain in economy and performance was demonstrated vividly.

Finally the effect of regular and high octane gasoline on the performance of the engine was demonstrated in the lecture room when Quigley operated a single cylinder engine. By switching from regular to Ethyl (high octane) gasoline and vice versa, and by varying the compression ratio and the time of ignition, knocking was observed to take place when regular gasoline was used and was eliminated when Ethyl gasoline was used.

The speaker at the Student Branch's Dec. 13 meeting was **J. T. Bugbee** of the Texas Co., who spoke on the subject of automatic transmissions. He began by discussing the disadvantages of the gasoline engine alone (without any mechanism to increase torque) at low speed.

Supplementing his lecture with slides, Bugbee showed that because of the low torque output of the gasoline engine at low speeds, the addition of a transmission to the engine was necessary to increase the torque at low speed. However, with the three speed manually operated transmission, it was necessary in starting the car from a standstill to cruising speed for the driver to perform eighteen operations in the process of shifting. People naturally became tired of shifting the transmission, and the result was that the engineers invented automatic transmissions.

The remainder of the talk was devoted to automatic transmissions. Bugbee first explained the difference between hydraulic couplings and hydraulic convertors, the former just transmitting the input torque, while the latter increased the torque output. He also explained the use of planetary gears on transmissions. From this preliminary background, Bugbee then went on to explain the various types of automatic transmissions in use today with the use of schematic drawings, which showed that all automatic transmissions are combinations of the following elements: fluid couplings or convertors and gear trains.

—Bill Bascom and John Favre

Oregon State College

The Dec. 5 meeting of the SAE Student Branch at Oregon State College heard an interesting talk on the subject of "Truck Transportation in Alaska." The speaker was **Eugene Coan**, one of the student members, who brought us a summary of his experiences in operating his own truck and semi-trailer in Alaska.

One of Coan's main topics was cold weather operation, with attendant difficulties in keeping the cab, engine, fuel, and gear lubricants warm; also discussed were special tires and gear ratios; road conditions; and reasons for very short life-expectancy of trucks operating in that area.

Colored slides were shown to conclude the meeting, which was acclaimed by the members to be one of the finest meetings held this year.

—Roy A. Renner

Wayne University

The fall semester at Wayne saw a membership drive by the SAE Student Branch that brought it among the leaders of campus groups. The first meeting, early in October, was devoted to planning a well-attended field trip to McCord Radiator Corp., and to two movies from Ford Motor Co. on the economic effect on the nation of such large-scale enterprises as Ford.

The November meeting featured a talk on the Chrysler "Firepower" engine by John B. Platner, who was in charge of the research program which led to the development of the "Firepower."

Plans were laid for participation in the annual student competition sponsored by Detroit Section for the Student Branches at Wayne and at seven other colleges in the area. In last year's contest on model jet cars, Wayne won first prize in design. This year the problem will be rebuilding or modifying a McCoy or Dooling 0.29 cu in. displacement engine with glow plug to obtain the highest rpm. Awards will also be made for the best designed test stand, and possibly for other features, at the January banquet.

—James L. Gullberg

Illinois Institute of Technology

Fifty-five mechanical engineering upperclassmen of the Illinois Institute of Technology of Chicago spent Dec. 14 in Detroit, touring automotive, defense and research establishments in the motor city. The visit was arranged at the Detroit end by Max M. Roensch of the Ethyl Corp., assisted by Fred Arnold of GMC Cadillac Division and Lt. C. W. Knapp of Detroit Arsenal. B. W. Bogan of Chrysler Corp. served as official host to the group for the Detroit Section of the SAE. Handling arrangements at Chicago were Robert M. Ladevich and Edward Mercanti of the Institute's faculty. Mercanti accompanied the group to Detroit.

The men were assisted on the plant tours by Dean Engel, engine engineer, Dodge Division of Chrysler Corp. Ethyl Corp. was host to the group for breakfast, and the Cadillac Motor Car Division of General Motors was host at lunch. The group visited the Fleetwood Body Division and the Cadillac Plant in the morning, and in the afternoon toured the Detroit Tank Arsenal and the Ethyl Research Laboratories.

This trip to Detroit was engineered by George Paul, SAE student chairman at Illinois Institute of Technology.

Journal Index Available

A complete Index covering the twelve 1951 issues (Vol. 59) of the SAE Journal is now available to members and subscribers free upon request.

At the Dec. 17 meeting of Central Illinois Section, speakers John P. Carroll and Harold L. McCormack, both of Caterpillar Tractor Co., examine slides. Left to right: John Findeisen, technical chairman of the meeting; John Carroll; Harold McCormack; Section Chairman J. W. Vollentine; and coffee speaker Paul Bourscheidt

Aircraft Magneto System Meets Requirements Well

• Southern New England Section

Louis H. Frese, Field Editor

Dec. 5—Nearly 100 members and guests heard **Stanley Terry**, chief engineer of the electrical division of American Bosch Corp., talk of possible developments in automotive ignition systems for both ground and air units. The modern aircraft magneto, he indicated, pretty well meets the 8 major requirements of aircraft ignition, which he listed as: utmost reliability, independence from the electrical system, light weight, long life with minimum attention, high altitude performance, high energy requirements, moisture resistance and radio interference.

Continuing flight and laboratory tests to evaluate improvements and performance point to the great reliability of the aircraft magneto, he said, while highest quality components help to insure such reliability. The system has a self-contained generator, not dependent on external electrical power supply, he said, adding:

The modern aircraft magneto regularly attains its goal of 1000 hr of operation without attention; it gets high altitude performance by pressurizing high voltage parts of the system or by use of low tension distribution at the expense of weight; its energy increases with speed, contrary to the decreasing characteristic of battery timers; the system is completely waterproof back to the magneto which is protected in the engine nacelle; and the magneto system lends itself to shielding since all generating and distributing components can be completely enclosed in metal.

The meeting was held at the Hartford Golf Club and featured an exhibit of operating ignition systems which created great interest. Both Scintilla Magneto Div. of Bendix Aviation Corp. and American Bosch Corp. helped to provide and demonstrate the equipment in the exhibit.

SAE Adopts New Viscosity Ratings

• Salt Lake Group

J. P. Bywater, Field Editor

Dec. 20—Society of Automotive Engineers and petroleum refiners are trying to clear up the confusion and set up standards of viscosity ratings that will cover all demands, stated **H. E. LaBelle**, of Standard Oil of California, Utah subsidiary of Standard Oil of Indiana, and Phillips Petroleum Company.

To help the membership understand the procedure used by the oil engineers to determine necessary grading of the viscosity of engine oils, LaBelle gave a description of the viscosimeter.

A viscosimeter is a comparatively simple device consisting of a specially shaped vessel equipped with a standard size orifice at the bottom end. This device is assembled so that the oil under test can be entirely surrounded by a liquid bath for the purpose of temperature control. The orifice at the bottom end contains a stopper which can be removed when the test is ready to run.

The procedure of the test is as follows: when the correct testing temperature is reached (as determined by thermometers placed in both the oil and the surrounding liquid bath), the cork is pulled from the bottom of the viscosimeter tube and 60 cc of oil are permitted to flow into a standard size receiving flask. The time, expressed in seconds, required for the 60 cc of oil to flow through the orifice is the viscosity of the oil. Thus an oil may be said to have 100 sec Saybolt viscosity at 100 F when it took 100 seconds for 60 cc of oil to flow through the viscosimeter at 100 F. These tests are commonly made at three different temperatures, 100 F, 130 F, and 210 F.

In cooperation with the Automotive Manufacturers Association, SAE has dropped the old SAE 10 oil and have added three new winter oils (5W, 10W, and 20W), and have changed the classification to a new standard for oil viscosities at various temperatures, LaBelle said.

Long Hops Required For Airplane Turbine Efficiency

• Northern California Section

J. C. Ellis, Field Editor

Dec. 18—Turbines as powerplants for commercial aircraft are on the way. **Raymond D. Kelly**, superintendent of technical development for United Air Lines, believes the turbine engine will be accepted by the aircraft industry much as the turbine replaced the reciprocating engine in steam plants and the diesel engine was accepted by the railroads. Kelly feels that present problems associated with turbine engines will be solved in time by the aircraft industry, and that in spite of high fuel consumption both turboprop- and turbojet-powered aircraft will be adopted by commercial airline operators and accepted enthusiastically by the flying public.

He stated that power demands for higher speeds point to turbines because of smaller weight and less drag, and that to fly efficiently with turbines you must fly faster and far greater distances than with reciprocating engines. Because high speed airplanes are hampered by taxi, climb and descent time requirements in achieving high speed-

efficiency, a 400 mph aircraft must fly 1400 mile hops to equal the efficiency of a 200 mph aircraft flying 500 mile hops.

Kelly concluded by stating "there's a turbine in your future" and indicated the extent of this trend by showing motion pictures he had taken on a recent trip to England and the Continent portraying the present development of turbine powered commercial aircraft abroad.

Morris H. Pomeroy was technical chairman for the meeting.

Analyzes Failure Of Avery Company

• Central Illinois Section

R. F. Hughes, Field Editor

Dec. 17—Two members of the Central Illinois Section, **John P. Carroll** and **Harold L. McCormack**, presented papers at the December meeting. Carroll, supervisor of wheel tractors and motor graders, Engineering Department, Caterpillar Tractor Co., gave the case for engineering, research and training in tracing the interesting history of a local industry in his paper, "The Story of the Avery Co., Formerly Peoria's Largest Industry". McCormack, supervisor of service training, Caterpillar Tractor Co., discussed the methods of cleaning parts in earth-moving equipment distributors' shops, in "The First Step".

According to Carroll, the idea of the Avery Co. sparked in R. H. Avery's mind when he was a captive Union soldier in the Andersonville Prison during the Civil War. Avery designed a mechanical corn planter by sketching in the sand of the prison court yard. After his release, Avery joined forces with his brother, C. M. Avery, and went into production of corn planters, stalk cutters and cultivators. The machines proved to be practical and well received which enabled the company to grow and prosper. J. B. Barthalomew, an excellent inventor and engineer, was made vice president of the company in 1892 and was elected president when C. M. Avery died in 1905. The company rapidly expanded and took on many new lines of machines, such as the Glide automobile, Avery trucks, threshing machines, steam traction engines, gasoline traction engines, small road graders and engine-powered cultivators not unlike the row-crop tractors of today. In 1920, the company was highly diversified with four large plants, one in Milwaukee, Wis., and three in Peoria, Ill.

In 1924, just four years later, the company went into the hands of receivership. Carroll attributes this

25 Years Ago

Facts and Opinions from SAE Journal of February, 1927

For a number of years the industry has been talking about making cars lighter but little has been done in this direction. The Weymann flexible type of body offers a way to do it.—W. G. Wall, Consulting Engineer, in discussion of Annual Meeting paper.

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Greater possibilities in body designing exist than ever before. The demand for low cars, good proportion in design, harmony in exterior finish, and comfortable seating will be governing factors in public buying. Simplicity will be one of the finer trends of the future.—R. H. Dietrich, Dietrich, Inc., in Annual Meeting paper.

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Transmission development has lagged badly for nearly a decade. Admittedly, there has been some progress in the direction of quietness of operation and decrease in size. But car ability is as badly handicapped today by the limitations of a three-ratio gearbox as it was years ago. The desirability of having more than three forward gear-ratios need hardly be debated.—C. A. Neracher and Harold Nutt, Durant Motors, in Annual Meeting paper.

■

You sell motor-cars or you don't, according to what the public says about your product. These factors determine whether the public talks about you at all and whether its talk is favorable or unfavorable: (1) car design, (2) well-built product, (3) advertising, sales, and service policies, and (4) the way management reflects ideas to the public. The whole art and science is to set up the largest amount of favorable talk.—R. H. Grant, Chevrolet, in dinner address at Annual Meeting.

■

One of the greatest future developments in the automotive field will take place through the training of personnel. Outstanding examples of the success of personnel training prove the possibility of a comprehensive application of apprenticeship in the industry.—H. A. Frommelt, in Annual Meeting paper.

Engineers owe it to their self-respect to make a more definite attempt to make every part of the motor-car readily accessible so that cost of operation can be reduced to a minimum and useful hours on the road increased.

The automobile should be gone over at least once a year with a fine-tooth comb, and these questions asked, "What is this part for?" and "Does this part do the work in the best possible way and to best advantage?"—H. M. Crane, GMC, at Annual Meeting Mystery Session.

■

The automobile industry has reached the point at which its product actually is good enough to be "sold" to the public.—C. F. Kettering, GMC, at Annual Meeting dinner.

■

A short time ago it would have been disastrous to take some cast iron cylinder-block or cylinder-head castings out of sand while at a bright-red heat. Today, under modern manufacturing methods, this procedure has become the rule rather than the exception. And this is done with a lower percentage of cracked and warped castings than was ever true before.—Arnold Lenz, Saginaw Products Co., in discussion at Annual Meeting Production Session.

■

Speakers at the Annual Meeting "Mystery Session" were B. B. Bachman, President 1922; H. M. Crane, President 1924; David Beecroft, President 1921; C. F. Kettering, President 1918; J. H. Hunt, President 1927; J. G. Vincent, President 1920; and Coker F. Clarkson, "The Dean of the School of Presidents."

■

Use of front-wheel brakes alone is not dangerous because—so long as the rear wheels continue to revolve—the car cannot pivot. But use of both front- and rear-wheel brakes simultaneously is dangerous if the braking pressures are not combined in correct proportion.—Johannes Plum, Royal Danish Legation, City of Washington, in Annual Meeting paper.

disaster not to over-expansion or lack of creative genius, but to the lack of proper engineering, research and training. The company was reformed based on these three foundations, but this reorganized company failed to survive the lean years of the depression. Rights to manufacture and sell parts for the Avery machines then in use were purchased by two local business men. Parts for machines still in use are available from Avery Farm Machinery Co., Peoria, Ill.

Harold McCormack pointed out that steam cleaners were inadequate to accomplish all cleaning problems facing a tractor service shop. Four different systems of cleaning are necessary for a well-balanced program. High pressure water is necessary to remove mud or dry dirt from tractors before they are brought in to the shop for disassembly. Steam cleaning is necessary to remove heavy grease or oil deposits on tractors. Sometimes, if these deposits are sprayed with a solvent such as Stanisol, they can be removed with high water pressure. Another useful cleaner is the vapor degreaser which utilizes chlorodiethylene vapor or some similar solvent to clean parts. A dip-basket and a bucket with a commercial solvent such as Gunk, Bendix Cleaner or similar cleaner is a humble but necessary part of any cleaning program. The dip-basket-bucket combinations are necessary to clean carburetor and magneto parts. In some shops, pistons are cleaned by a similar method.

McCormack states that the high-pressure water system should deliver 12 to 15 gals per hr at 350 to 400 psi to be adequate for most tractor shops. A steam cleaner should convert 240 gal of water per hr to wet steam. Dry or superheated steam does not do a satisfactory cleaning job. The vapor-degreasers are relatively expensive. McCormack showed a slide of one costing $1700 that was large enough to accommodate an engine block approximately 4 ft × 2½ ft × 18 in.

In any tractor overhaul or service repair, the first and one of the most important steps is proper and adequate cleaning of the machine and parts.

Technical chairman of the meeting was John Findeisen. Paul Bourscheidt, as coffee speaker, talked about his recent trip to Rome and, in particular, elaborated upon momentos of the life of Christ which are enshrined in that city.

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Urges Better Use Of Available Petroleum

• Southern California Section

P. Kyropoulos, Field Editor

Dec. 13—Last year automotive equipment in the U. S. burned 40,000,000,000 gal of petroleum. Where does this fuel come from and what does it look like? These questions were discussed by **W. S. Mount**, manager, Products Engineering Department, Socony-Vacuum Oil Co.

Using ten large and excellently descriptive charts, Mount said: "To record-breaking civilian demands are added the burden of upset conditions in Iran and of the defense program. For the near future at least, new refinery construction appears limited largely to aviation fuel and military projects. With the pinch already felt in some fuels, engineers should study refinery trends and see if we can make more effective use of the quality and volume of petroleum stocks available under present conditions."

Among the significant trends is the development of the long term cracking trend to the point where middle distillates are now predominantly cracked. Another outstanding trend, complicated by today's conditions, is the dif-

ficulty of manufacturing high octane gasolines, plus the very high cost per octane number, as the quality reaches up into the 90 plus range.

A method of analysis has been offered in this paper using motor gasoline as an example, whereby refinery ability may be more efficiently applied to today's conditions of gasoline consumption. Making certain assumptions for this illustration, the example brings out the following:

A. Premium gasoline quality cannot be manufactured economically to an octane number which eliminates knocking from all passenger cars, but adequate mechanical service know-how has been developed to eliminate the knock from the troublesome vehicles.

B. Premium gasoline sales volume is currently high enough to warrant a fairly wide spread in quality between premium and regular grades—wider than that existing in many parts of the country today. The engineering analysis, which is subject to a number of qualifications as outlined in the paper, indicates that available refinery quality would be employed most efficiently if the quality stocks were distributed between the two grades so that the spread between them was about 9 octane numbers. The analysis indicates further that efficiency is sacrificed if premium sales fall below the present national figure of about 28% of total gasoline (about 40% of gasoline for passenger cars). When proposed method of analysis is applied by any one company in consideration of its own sales and manufacturing programs, the figures probably will come out with some adjustment from the numbers which have been mentioned. Nevertheless, the principle of analysis and the objective of a fairly wide quality spread are sound.

C. The oil industry is rapidly reaching the point where further quality increases mean a loss in the percentage of quality gasoline. This fact, plus the refinery problem of disposing of low octane gasoline stocks, is a further strong argument in favor of an efficient combination of grades and a reasonably wide quality spread.

A similar method of analysis for other fuels, such as diesel and No. 2 fuel oil may also show benefits which ultimately could be passed along to the consumer.

One interesting angle has developed in studying the possible implications of an accelerated military program. A substantial increase in the manufacture of jet fuels would mean refinery expansion of a type which would contribute little to the quality of gasoline which could be made for later peacetime automotive consumption; whereas, construction to produce aviation gasoline in World War II is estimated to have contributed the equivalent of 5 octane numbers to improvement of motor gasoline.

Experiences Recounted By Cross-Country Driver

• Cincinnati Section

Walter Walkenhorst, Jr., Field Editor

Nov. 26—"You can't buy experience or safety" **E. G. (Cannon Ball) Baker** stated before 95 members and guests of the Cincinnati Section.

Baker divided his address into three parts: First, an interesting recapitulation of his famous cross-country runs. Second, the secrets of heat, air and proper acceleration action in good carburetion. Third, safe driving habits developed through many years of unusual driving experience. He suggested a slogan that it would be well to remember, "Always Stay This Side of Danger."

Following the talk and question period Baker was presented a set of racing flags autographed by the officers of the Cincinnati Section.

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Describes New Ford 6-Cyl Engine

• Chicago Section
C. B. Seymour, Field Editor

Dec. 13—The sensational new Ford 6-cylinder engine was described by Chief Engineer **E. S. MacPherson** to the largest regular meeting crowd in recent years. Over 800 members and guests were present to hear of the most recent advancements in passenger car engine design.

American ingenuity in engine design has finally overcome European tradition, and engine characteristics will conform to the requirements dictated by our needs.

Larger bores and shorter strokes, square engine to designer, and more economical and longer lasting engines to the motoring public are promised.

More horsepower with less weight, and greater gasoline mileage with less frequent repairs really sums up the speaker's remarks.

The mechanical and thermal efficiencies have been improved to a degree thought impossible a few years ago, which, of course, is the reason for improved economy and performance.

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Jet Engines Needed for Fighters

• St. Louis Section
W. H. Cowdery, Field Editor

Dec. 11—Shortage of engineers and rapid obsolescence of new designs were among the current problems of aircraft production of which **A. T. Colwell**, Thompson Products' vice-president of engineering, talked at the dinner meeting which 135 attended here tonight.

Jet engines, Colwell said, are revolutionizing aircraft today. The Korean war has proved that reciprocating engines are not speedy enough for fighter aircraft. Nuclear power, he said, can be put to work by following the principle of using heat energy for steam generation.

In attendance at the meeting were George P. Dorris, who has been an SAE member since 1910 and A. J. Mummert, president of McQuay-Norris, who joined in 1915.

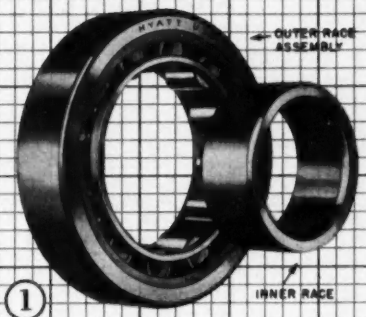
High Standards For Airline Mechanics

• New England Section
George T. Brown, Field Editor

Dec. 4—Airline maintenance is achieved by a group of people working toward one end, and that is to deliver an airplane to the operating department in the best mechanical condition, said **D. W. H. MacKinnon**, director of engineering and maintenance of Northeast Airlines, Inc. The work laid out for the maintenance group is covered by volumes of company manuals. These manuals are necessary as reference books and completely cover all of the details of dismantling and assembling all parts of an airplane. A majority of aircraft mechanics carry either an airplane or airplane engine license, or both, obtained from the Civil Aeronautics Administration after appropriate tests. The normal skill of an airplane mechanic, together with the reference material which he has available, makes a combination that is hard to equal in any mechanical line.

MacKinnon emphasized the importance of the thoroughness of the workmanship of the mechanic. Each mechanic is conscious of the fact that there might not be a 'tomorrow' for that plane if his attitude was indifference. All routine maintenance is controlled by maintenance specifications authorized by the C.A.A. and enumerates various components of the airplanes and all accessories. In the case of the Northeast Airlines, an out-

Some things you should know about HYATT HY-LOADS



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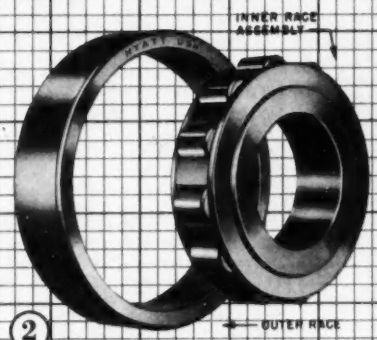

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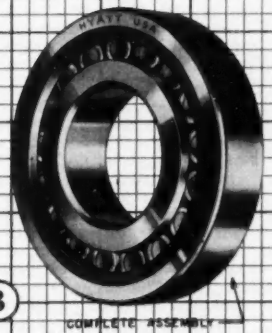

3

The Hyatt Hy-Load line of roller bearings, manufactured in three series, in a wide range of sizes and types, offers you many desirable product design and assembly advantages.

1 If design requirements are such that a larger shaft diameter is desirable to produce greater rigidity without disturbing boundary dimensions, a separable inner race type Hyatt Hy-Load bearing can be used with the inner race omitted. The rollers then operate directly on a suitably hardened and ground shaft.

2 When the housing bore must be kept to a minimum, a separable outer race bearing can be used with the outer race omitted. The rollers then operate directly in a housing bore of suitable hardness and finish.

3 If the design requires that the bearing be installed as a unit, Hyatt also provides non-separable types of Hy-Load bearings.

More detailed information on Hyatt Hy-Loads or any of the other popular types of Hyatt Roller Bearings for automotive applications, may be had upon request. Hyatt Bearings Division, General Motors Corporation, Harrison, N. J. and Detroit, Mich.

HYATT ROLLER BEARINGS

ward visual inspection is performed daily and a periodic inspection at 75, 180, and 350 hr. In addition, there are overhaul periods at specific intervals.

The question period brought out:

1. That representatives of maintenance groups of all lines meet periodically on a non-competitive basis and exchange ideas on an agenda form with due regard to safety and efficiency.

2. That tires usually last from 400 to 500 landings and are retreaded approximately 5 times.

3. With reference to reversible props, the emphasis is on saving brakes and not tires.

4. Engines receive a major overhaul after about 1,100 hr.

5. Aviation gas contains 100 octane.

6. Spark plugs are changed after about 180 hr.

7. Mechanics wages at present are from $1.72 to $2.05 per hour.

Prior to the speech an interesting movie with sound entitled "British Aircraft Review 1949" demonstrated piston engines, jets, turboprops, and gas turbines, and their relative speeds and altitude climbing.

Harry Stanton, automobile editor of the Boston Globe, was coffee speaker. He declared that material and labor shortages would cause changes in the delivery dates for most 1952 model cars.

Design Futures Are Airlines Problem

• Montreal Section

Frank B. Thompson

Dec. 10—The cost of modern commercial aircraft is so high that airline managements have to figure on still having in 1959 the aircraft type which they order today, **Gordon R. McGregor**, president, Trans-Canada Air Lines, told his audience here tonight. A modern, 4-engined, commercial aircraft costs anywhere from 1½ to 2 million dollars.

Airline managements are faced with three alternatives, he continued:

(1) Ordering piston engines (with or without the compound feature) . . . with the possibility that they will be seriously lacking in passenger appeal by 1956 or 1957;

(2) Ordering turboprop engines—which offer a reasonable compromise as regards fuel economy—but whose maintenance costs are still unknown; or

(3) Ordering full jet engines, knowing that most of its operation must be at 35,000 ft or above—and that traffic control at crowded airports still has no solution for the stacking problem.

McGregor's own decision, reflected in TCA's action, was to place an order last June for five Super Constellations for delivery beginning late in 1953. These aircraft will use the Wright 3350 compound engine, which may be regarded as a stepping-stone between the piston engine and the turboprop engine.

The air commerce of 1961, he concluded, will dwarf anything we have yet seen, despite the fact that world air traffic for the last four years has increased by 25% per year.

Experts Discuss Maintenance Practises

• Milwaukee Section

Leo Lechtenberg, Field Editor

Dec. 7—"How To Keep Them Rolling" was the subject of talks by **Henry L. Debbink**, **Harry R. Stiedemann** and **Fred J. Schwerman**. Debbink, who is superintendent of gasoline vehicles of Milwaukee Electric Railway and Transport Co., explained how they keep the city bus fleet rolling a million and a half miles a month. Stiedemann, superintendent of the Bureau of Municipal Equipment, explained how the City of Milwaukee services their equipment, and Schwerman, who is vice-president of the Schwerman Trucking Co., described how to keep local and long distance truck fleets in operation.

Schwerman said that his company has hauled over two million barrels of cement this year on the Pennsylvania Turnpike. He reported that they averaged approximately 20,000 miles per tire in Pennsylvania due to the braking and pulling problems, while in Ohio they sometimes averaged 70,000 miles per tire. He also said that they had tried Gunite brake drums in Pennsylvania and that these drums appear to give an improved life over the standard brake drums. He stated that the Dutch eye spring has remedied problems of breakage of springs at the eye. On their fleet, the man in charge of the trailer is required to turn in a card on failures as soon as the truck comes in off of the road. This truck cannot go out on the road and cannot be filled with gasoline until this card is signed by one of the mechanics, making the

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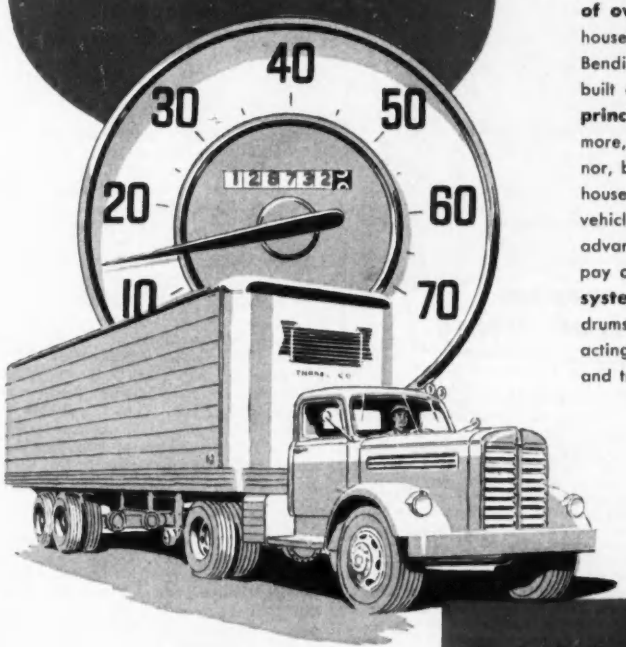

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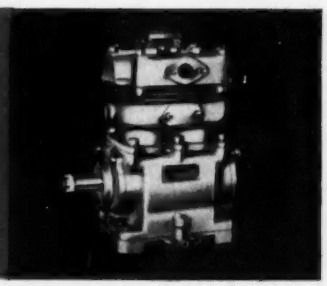


BENDIX-WESTINGHOUSE AUTOMOTIVE AIR BRAKE COMPANY

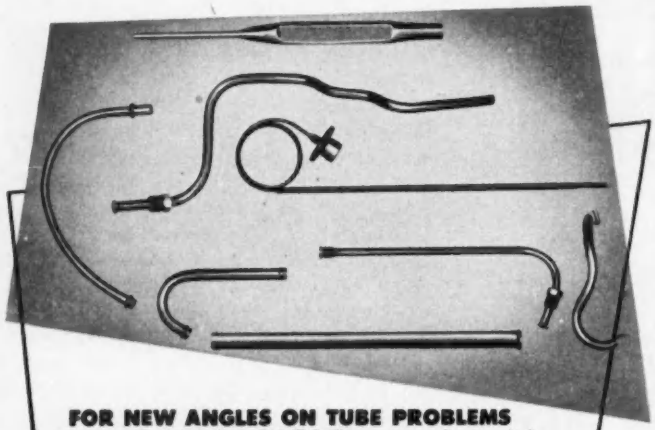
ELYRIA, OHIO BERKELEY, CALIF.

mechanic responsible for the correction or inspection of the failures reported. Schwerman reported that they have operated some units on propane gas, and so far the operation has been very satisfactory.

Debbink reported that each bus of the Milwaukee Electric Railway and Transport Co. receives a general inspection every 20,000 miles. Every 100,000 miles they have a special inspection, which usually includes a re-ring job. The gasoline buses operate on 76 octane gasoline and Diesel buses use 50 cetane oil. The lubricant used conforms to MIL-2-104 specification. On the trackless trolleys, where some trouble was experienced with tapered roller bearings, the maintenance department has now taken precautions to prevent entry of dirt into the bearing while servicing the buses. As soon as bearings are removed from the wheels, they are washed and placed on a selfsealing wax paper; the wax paper is then folded over and sealed so that the bearing remains clean until it is reassembled into the bus.

On the torque converters, the converter fluid is changed, not at any given mileage, but rather when the color of the fluid begins to change. This change has averaged around 40,000 miles and has proven satisfactory. Regarding tires, the treads average 50,000 miles per tread and the tires average two recaps per tire. However, no recaps are used on front wheels. During the discussion, it was pointed out that no anti-freeze is used in any of their buses.

Stiedemann said that the Bureau of Municipal Equipment has installed a tower for rapidly filling the fuel tanks of their different vehicles. By this method, one operater can fill the fuel tanks and record the fuel used on seven vehicles at a time. MIL-2-104 oil is changed every 2,000 miles and the oil filters are changed every 8,000 miles. He reported that by placing the squad car batteries on the trunk of the squad car, battery life had been increased 100%



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Practical Aspects of LPG Fuels Are Discussed

• Detroit Section

W. F. Sherman, Field Editor

Dec. 10—Practical aspects of the use of liquefied petroleum gas in motor vehicles were discussed at Detroit Section meeting in the Rackham Memorial Building. The technical story of the petroleum industry about the use of propane as a motor fuel introduced the subject, and a report by the chief engineer of an important user of the fuel drove home many of the important points.

F. E. Selim, manager of Philgas Motor Fuel Sales, Phillips Petroleum Co., reported that many bus, truck, and taxicab fleets have undertaken conversion to LPG and that supply studies indicate a huge potential surplus of propane above and beyond the requirement for presently established markets. In contrast the demand for fuel oils is rapidly approaching the limit of the available supply from crude oil processed to meet the requirements for gasoline. The situation is further complicated by the fact that the best diesel fuels are also the best feed stocks for catalytic cracking plants to process into high octane gasoline. This would indicate that the future availability of good diesel fuels will depend almost entirely upon the value of these materials as compared to the value of gasoline.

The ideal propane engine, he said, is little different from a gasoline engine except that it would be designed to operate at high compression ratio and would have a cold intake system designed for maximum breathing capacity. Fuel distribution problems are virtually eliminated since the fuel enters the intake system as a dry vapor.

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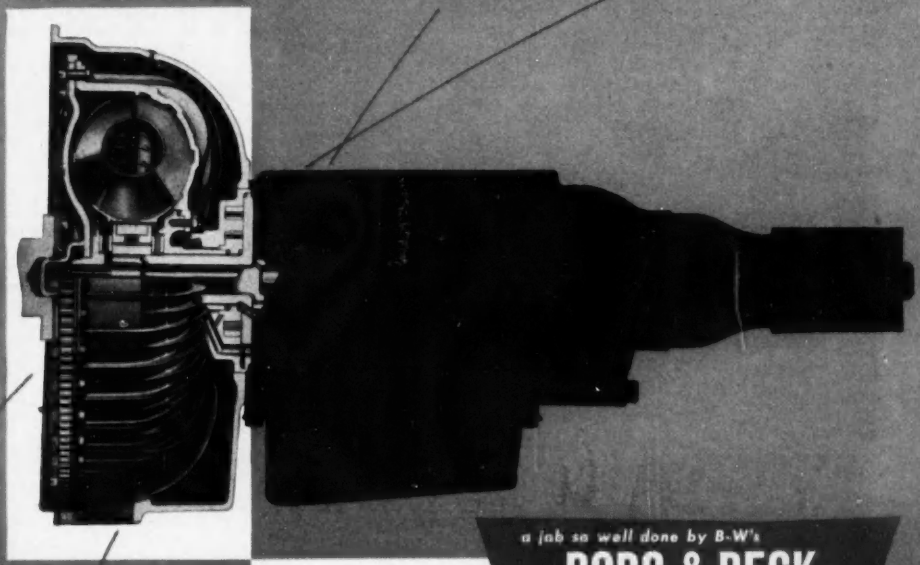

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well-designed engines operated on propane last longer than when operated on gasoline. This is believed to be almost entirely due to the absence of liquid fuel in the combustion chambers, better fuel distribution and the absence of combustion-chamber deposits and crankcase oil contamination. Much more information on this subject is required before an accurate evaluation of this difference can be made, he added.

Selim stated that, because of the cost of storing and dispensing propane in small quantities, the use of propane as direct motor fuel is probably limited to fleet operations where sizable volumes can be handled through each installation.

With all these posibilities the use of propane as motor fuel presents a challenge to everyone concerned—the many branches of the petroleum industry, the equipment manufacturers, transportation companies, legislative and regulatory bodies, and consumers—to cooperate to get the most out of propane as a direct motor fuel, he concluded.

S. D. Forsythe, chief engineer, Chicago Transit Authority, operator of 550 coaches using LPG, said that the Authority adopted the fuel after being satisfied on three points: safety, public acceptance, and economy.

Safety precautions begin with the dispensing installation. Excess flow valves and a safety valve are used on the storage tanks. Dispensing equipment makes use of a bayonet type filler spout which operates to seal off a small "air storage" tank inside the main fuel tank on the vehicle. This ingenious arrangement permits the filling of the tank to capacity, with the smaller tank remaining empty to provide room for expansion. There are three shut-offs between the tank and the engine. One is a spring loaded ignition solenoid, another is a valve at the tank and the third is at the "outer regulator" which is part of the fuel induction system. There is additional safety in the fact that the fuel is carried in a "closed" system, not made of sheet metal but with quarter-inch boiler plate having a 1000 psi burst, with pressures actually running 250 psi. Finally, from the safety viewpoint, LPG fires do not spread. They are more like a concentrated blow-torch fire, if they occur.

Public acceptance has been at a very high level because the exhaust is odorless, vehicle acceleration is high, and the engines are quiet. Charter service requests for the LPG vehicles in Chicago indicate that the vehicles are considered highly desirable by the customers.

As pictured by Forsythe, the economic advantage started with an initial price quotation of $3000 less than for competitive vehicles, when the advertisement asked for either propane or diesel powered buses. Fuel cost is approximately 4¢ a gallon compared to 10¢ for gasoline, and an intermediate figure for diesel fuel. In terms of cost per mile, gasoline is computed at 5¢ per mile, diesel operation at 3½¢ per mile, and LPG at 3¢ per mile. Operating experience to date is based on approximately 1,500,000 miles per month. Experience in various similar operations indicates that there will be less maintenance, with better life for distributor points, spark plugs and valves.

Some operating difficulties have been experienced. Some of these are attributable to high sulfur content in the fuel on one occasion. At one time odors proved to be a problem because a deodorant in the fuel precipitated in the fuel at elevated temperatures. There have been some problems due to the design of regulators and an epidemic of engine dying on windy, gusty days. The latter required installation

ENGINEERS WILL BE INTERESTED in this new series of DeLuxe Ads appearing in leading automotive publications. They tell mechanics why the exclusive Spring and Cone are essential to the DeLuxe Method of FULL OIL CLEANSING. They show how the DeLuxe Spring prevents cartridge collapse ... how the DeLuxe Cone feeds oil the LONG WAY - from bottom to top - for FULL OIL CLEANSING . . . .

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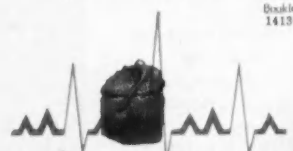
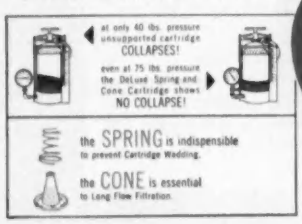
Don't take the heart out of your DeLuxe Filter by using substitutes. The spring supported cotton wound cartridge is essential to DeLuxe principles of actual oil cleansing. No DeLuxe Filter can function properly without the patented Spring-and-Cone. No other cartridge has the patented Spring-and-Cone ... no other cartridge can give you full cleansing action in the DeLuxe Filter! Get the FREE "Key to Clean Lubrication" Booklet for all the facts. Write: DELUXE PRODUCTS CORP., 1413 Lake Street, La Porte, Indiana

use only Genuine DeLuxe Cartridges

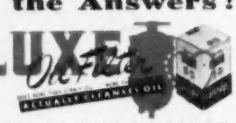


Just as the erratic beat of a bad heart interrupts blood flow so a collapsed substitute cartridge interrupts oil flow


at only 40 lbs. pressure unsupported cartridge COLLAPSES!
even at 75 lbs. pressure the DeLuxe Spring and Cone Cartridge shows NO COLLAPSE!
the SPRING is indispensible to prevent Cartridge Wedding.
the CONE is essential to Long Flow Filtration

Be a Man Who Knows the Answers!

THE MEN WHO KNOW THE ANSWERS, INSIST ON DELUXE



R-5450 SAE

BUS OPERATORS ARE MEN WHO KNOW! Year after year they vote DeLuxe the Number One Filter as indicated by the Winners of Bus Transportation Maintenance Awards. Of 21 winners in 1950, 17 were DeLuxe Users. Year after year it's the same story.

Longer wear-life is another *extra* designed into every Fuller Heavy-Duty Transmission.

These gears pictured here, for example, were taken from a Fuller 5-A-920 which logged 750,000 miles . . . 30 times around the world . . . WITHOUT OVERHAUL.

That's why owner Stan Iskra, of Bellevue, Ohio, says:

"After seeing all of the mileage which I have gotten out of this transmission, I wouldn't think of buying another truck that did not have a Fuller Transmission."

This particular tractor was in service hauling steel from Pittsburgh to Detroit and nearby points, part of the time pulling a double-dolly train. But its *longer* wear-life record could have been posted in any kind of heavy-duty hauling—off-highway or on—because there is a Fuller Transmission to match every "road and load condition." More than 101 models, in fact.

Choose a Fuller Transmission or Auxiliary for your rig. You'll find, like Stan Iskra, that it pays in more tonnage hauled at the end of the year for far less, particularly in maintenance.

Unretouched photographs above show the original gears, just as they came out of Stan Iskra's 5-A-920 Fuller Transmission, after millions upon millions of punishing contacts.

Fuller TRANSMISSIONS

FULLER MANUFACTURING COMPANY (Transmission Division), KALAMAZOO 13F, MICHIGAN

Unit Drop Forge Division, Milwaukee 1, Wis. • WESTERN DISTRICT OFFICE (SALES & SERVICE—BOTH DIVISIONS), 1060 E. 11th Street, Oakland 6, Calif.

of pressure balancing arangements in the fuel supply system for the engine.

Forsythe indicated satisfaction on the part of Chicago users of the equipment. Selim said that greater usage of LPG will help balance the utilization of petroleum. It has economic possibilities and also possibilities in emergency periods. He suggested that engine builders do something about helping to increase the usage of LPG.

J. R. Bartholomew, vice-chairman of Truck and Bus activity, presided.

All-Hydraulic System Satisfactory on Buses

• Washington Section

Lewis C. Kibbee, Field Editor

Dec. 18—All-hydraulic power operation of the control devices or auxiliaries of a large transit bus is now an accomplished fact, **Robert H. Fritzges**, Mack Mfg. Co., assured his small group of intensely interested listeners. He described in some detail such a system as applied to a new bus designed by his company.

Lewis C. Kibbee, American Trucking Association, was technical chairman of the meeting which was held at the Burlington Hotel, Washington, D. C.

As a result of the all-hydraulic control system, Fritzges said, the wheels of the bus can be turned back and forth with less effort than it takes to turn the wheels of a passenger car moving at 20 mph. The system is designed to handle on a city-type bus such diversified jobs as brakes, brake interlock, throttle, operation of the clutch and direct-drive cylinder in the automatic transmission, entrance and exit doors, and windshield wipers.

Maintenance required on the hydraulic system of an experimental bus during a five year period was well within acceptable limits, Fritzges said, and certain operating characteristics, including steering and brakes, were well received by the test drivers.

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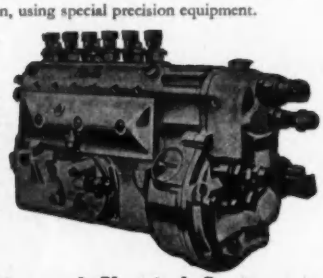

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Brake Efficiency Reduces Ton-Mile Costs

• New England Section

George T. Brown, Field Editor

Nov. 13—"It is impossible to handle the thousands of trucks and trailers making up the daily traffic of our great motor transport system with the largest degree of safety and economy unless everyone concerned has learned what the brake will do and how the best performance can practically be obtained. No single factor in the motor transport field has done more to increase truck and trailer carrying capacities, reduce ton-mile costs, make relative high speeds safe or limit the loss and damage account than the brake; and none has greater present or future possibilities in that direction." These were the opening remarks of a talk by **Stephen Johnson, Jr.**, chief engineer of Bendix-Westinghouse Automotive Air Brake Co.

Movie Describes Air Brake System

Preceding the speech a motion picture with sound entitled "Air Brake Operation and Maintenance" described in detail the various units comprising the air brake system. The action of the air-compressor as a pumping system, the air-reservoir and air governor as the controlling influence on the air presssure, the treadle valve, relay valves and brake chambers as application of the pressure, the slack adjusters, brake cams and brake shoes together with brake drums, the latter group comprising the foundation brake rigging and the final application of

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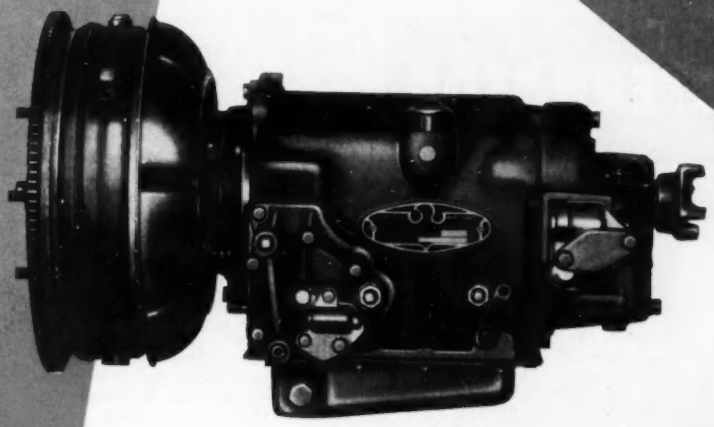

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DETROIT 14, MICHIGAN

deceleration, were all clearly shown and described in their respective functions in the air brake system.

Johnson declared further, "It is becoming more evident to all those interested in this matter of brakes that a high brake efficiency is of great value; but if it is to be secured and preserved, it is essential that adequate brake departments should be established and maintained, competent both to care for the brake apparatus and instruct men as to its proper use."

A number of slides were shown and described by the speaker in reviewing the terminology and basic factors peculiar to air brakes and graphically describing three separate functions and the time element as a contributing factor in their application. The three are:

A. Driver Reaction
B. Actuation of Air System
C. Actuation of the Foundation Brake

The question period was an augmentation of the factual evidences presented in the paper.

Chairman Lewis B. Ebbs reported that C. G. MacDermot, field editor, has joined the armed forces and complimented him for the excellence of his work in covering the annual outing and stated that George T. Brown, superintendent of maintenance, Johnson Bus Lines, Inc., would take his place as field editor.

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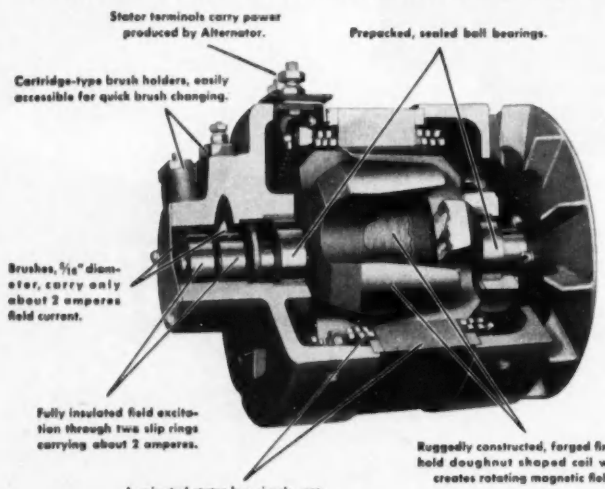
"POWERHOUSE" OF THE REVOLUTIONARY
LEECE-NEVILLE AC-DC ALTERNATOR SYSTEM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ALTERNATOR SYSTEMS • GENERATORS • CRANKING MOTORS
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Describes B-36 Propulsion System

• Texas Section
A. P. Johnston, Field Editor

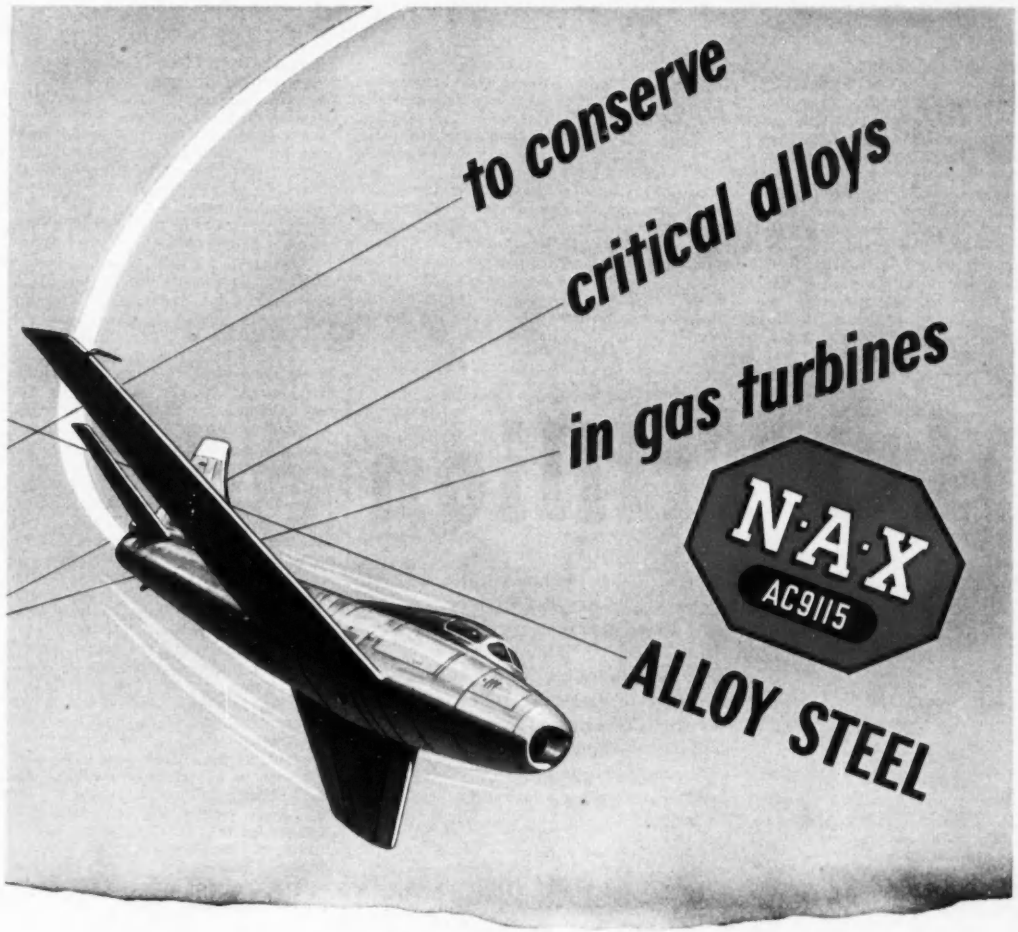
Dec. 14—**C. A. Savage**, chief of propulsion at Convair's Fort Worth Division, spoke on the modern B-36 and its reciprocating engine power plant.

Data on the B-36 presents it as a tremendous machine hard to comprehend in size or capabilities. It has a 230 ft wing span of almost 5000 square ft lifting area, a 162 ft long fuselage, 47 ft high tail, and horizontal tail area almost equal to the wing area of the B-24 Liberator. Design gross weight is approximately 357,000 lb. Six pusher reciprocating engines with 19 ft diameter propellers and four turbojets comprise its power plants.

During the conception of this airplane back in 1941 and 1942, the "laminar flow" type airfoil was being actively developed. It was largely to take advantage of this development that the pusher arrangement was adopted, despite the introduction of several new problems. These included propeller and wing trailing edge vibrations caused by passage of the blades through the wing wake, design of efficient inlets and long ducts with low losses, provision of ground cooling air without benefit of propeller slipstream, and establishing suitable balance and wing flutter limits with powerplant weight located rearward on the wing. Needless to say, these problems have been solved, and although the expected "laminar flow drag bucket" has not generally been realized in full scale practice, the pusher arrangement has resulted in a clean wing of unusually low drag.

It is also of interest that the wing sweep, incorporated for reasons of airplane balance, results in a significant increase in critical Mach number—an effect not anticipated in those days when the favorable effects of sweep were known only to the creators of comic strips and fantastic fiction.

Pratt and Whitney Wasp Major piston engines are the heart of the main powerplants of the B-36. These are 4 row, 28 cylinder engines equipped with water injection, two position spark advance, manual lean mixture control,



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N-A-X AC9115 ALLOY STEEL has high strength and toughness values at temperatures ranging from −70° F. to +1,000° F. It can be readily cold formed into the most difficult shapes; its response to welding by any process is excellent. It must, however, be suitably coated for protection against cold or hot corrosion.

Investigate the outstanding properties and characteristics of N-A-X AC9115 ALLOY STEEL and, through its use, conserve the critical material so necessary to our nation.

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low tension ignition, individual cylinder fuel injection, and .375 : 1 reduction gear. Two turbosuperchargers per engine operate in parallel, or one may be by-passed for cruise power operation. Each turbosupercharger turbine develops up to 500 hp. Charge air reaches the turbos through ram ducts from the wing leading edge, or through dust filters in the louvred bottom of the nacelle, or through pre-heat ducts which draw heated engine cooling air from the power section of the nacelle.

Power is set primarily by means of engine speed and turbo boost, since the carburetor throttles are wide open for all normal operation except descent and landing. Engine speed is governed by the Curtiss Electric constant speed propellers. Turbo boost is regulated by a Minneapolis-Honeywell electronic control. The latter is a bridge system in which the voltage drop across a potentiometer coupled to the turbo wastegate actuator must balance the net voltage drop of potentiometers coupled to the master turbo control lever, individual engine control knob, overspeed governor, and pressurtrol unit. The pressurtrol senses turbo compressor discharge pressure and signals any change therein by unbalancing the bridge. This signal, amplified, then causes current to flow through the wastegate actuator, moving the wastegate until its potentiometer cancels the signal from the pressurtrol. Thus, compressor discharge pressure is automatically maintained nearly constant, regardless of changes in altitude or airspeed, within the physical limits of wastegate travel and the turbo speed limit, which is nearly 25,000 rpm.

Extension of B-36 altitude capabilities, well beyond original expectations, has made engine lubrication at high altitude one of the more vexing development problems. The conventional type of lubrication pump is subject to cavitation at low inlet pressure, which has required special measures to assure adequate flow of oil into the engine at extreme altitude.

Engine scavenge pumps are also subject to cavitation at low inlet pressure, and as the B-36 operating altitudes increased, there was a brief but hectic period in which the airplane was plagued with "oilicles." Due to falloff in scavenge pump performance, the crankcases loaded up to such a degree that foam and liquid oil became entrained in the flow through the engine breather line. The oil thus vented ran along the wing until the cold air blast congealed it and tore it loose in large, solid chunks, which were then blown into the propellers and flung in all directions. Many of the chunks struck the fuselage, doing rather serious damage, but, needless to say, the most serious aspects of this phenomenon was the sudden loss of lubrication when the oil system went dry. The immediate remedy for this problem was pressurization of the crankcase to increase scavenge pump inlet pressure, and later engines have been equipped with higher capacity scavenge pumps.

The grade of oil used has a pour point of about 0 F and freezes hard at lower temperatures. Consequently, special provisions are required to insure lubrication during cold starts under Arctic conditions. This is accomplished by diluting the circulating oil with gasoline prior to shutdown in cold weather. Diluted oil is segregated from the main oil supply by means of a hopper, or tank within a tank, system. During warmup, the gasoline is boiled off on contact with hot engine parts, and the main oil supply is simultaneously warmed up by heat transfer from the circulating oil, so that fresh oil is soon available to replace the volume of gasoline boiled off.

Exhaust gases are collected in seven manifolds, each handling a bank of four cylinders. These headers feed into a collector ring, to which are connected twin tailpipes, one for each turbo. The headers are engine mounted and the remainder are airplane mounted. Hence, the system contains many flexible joints to permit relative motion between, as well as thermal expansion of, these parts. The

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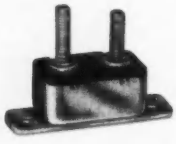

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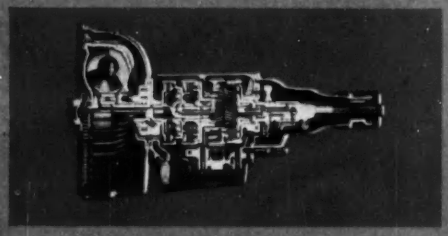

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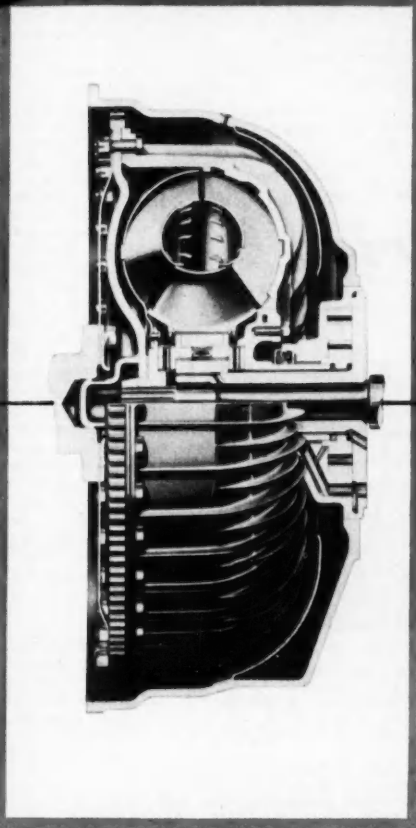

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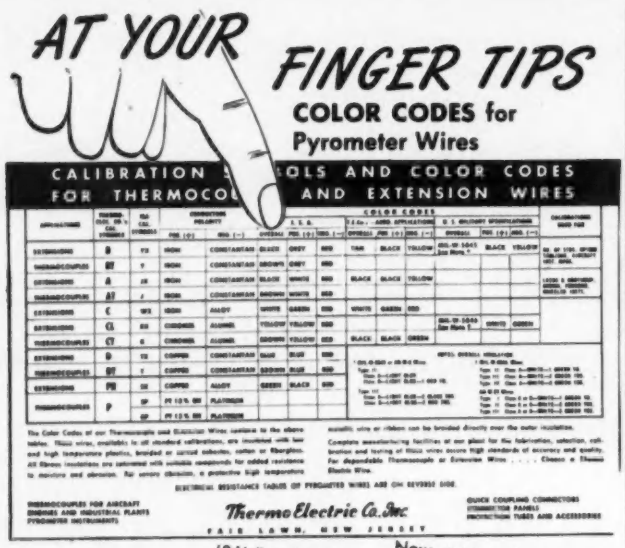

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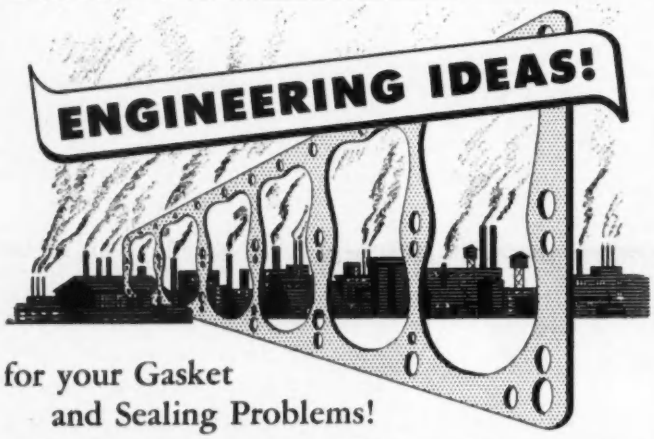

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collector ring is shrouded and cooled by forced convection, and the hot shroud cooling air may be diverted into the hollow propellers for anti-icing purposes.

An exhaust gas heat exchanger is located in each tailpipe ahead of the turbos. The transfer of heat serves to extend turbo life by decreasing turbine temperature, and the heated air may be utilized for wing and tail anti-icing and also for crew compartment heating and defrosting. Air for the latter, which is bled from the turbos, is heated by a secondary heat exchanger located in the tail anti-icing duct. The 12 exhaust gas heat exchangers provide up to 3,000,000 btu per hour for these purposes.

Two of the more unique features in the B-36 engine cooling system are the engine cooling fan and the exit plug ring. The fan compensates for duct pressure losses in flight and also provides ground cooling, in the absence of a propeller slipstream. The plug ring is an annular member which moves fore and aft to vary the area of the exit annulus, thus controlling the flow of air across the cylinders. The fan is driven by 2-speed fluid couplings in the engine accessory section. The high ratio is used for cooling at extreme altitudes and for maximum provision of anti-icing air, which is bled from the fan diffuser.

Use of the high ratio is restricted to low engine speeds at low altitude, because of drive structural limits. Barring drive failure, the fan would absorb about 1000 hp if left in high drive at take-off rpm, whereas fan power for cruising is typically 25 or 30 hp.

The engine cooling fan now being used is of Convair design. It consists of six highly cambered blades, has no contravenes, and contains cast-in electrical anti-icing elements. The requirement for anti-icing provisions was the main incentive for developing this fan, since the original fan assembly contained 34 closely spaced blades and 72 sheet metal contravanes—an arrangement very difficult to anti-ice.

The fan drive shaft is co-axial with an alternator drive shaft. Four of the engines are equipped with 40 kva alternators, an electrical power supply which could probably accommodate a town of about 1200 population, but none too much for the maze of electrical equipment carried on the B-36.

In a general discussion period following the talk, other aircraft propulsion systems were considered. These included turboprop, turbojet, and nuclear energy systems.

Two Speakers Highlight January Meeting

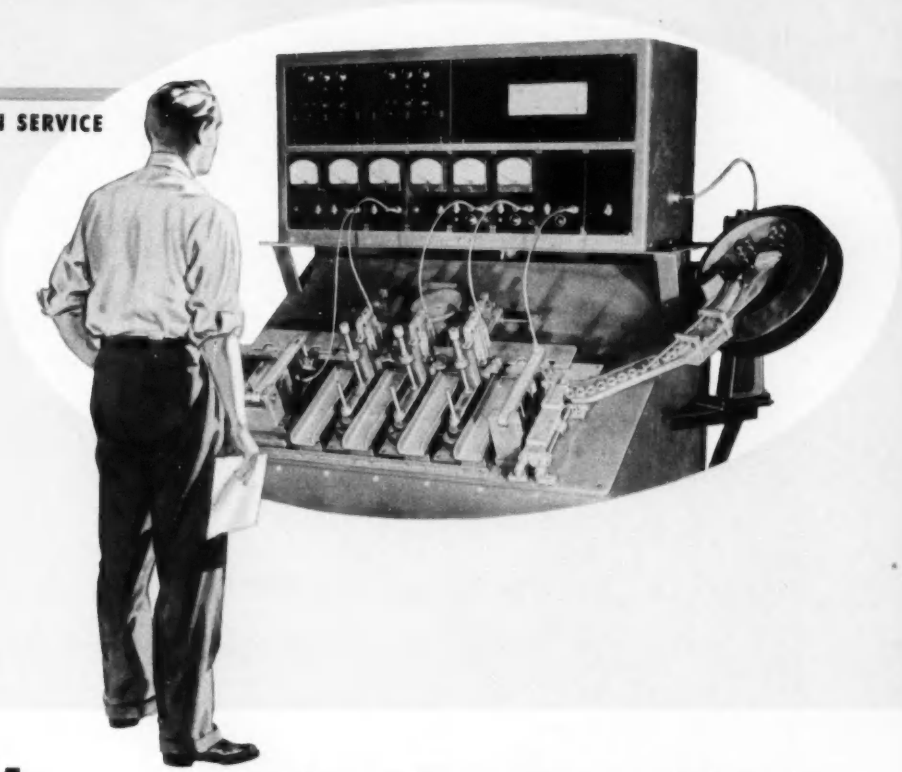
• New England Section

George T. Brown, Field Editor

Jan. 8—The recent increase in interest in Liquefied Petroleum Gas as a motor fuel, particularly in the bus industry,

Spicer

SPECIALISTS IN SERVICE



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Spicer ability to "feel" and control molecules . . . and all the factors that influence the most meticulous precision requirements . . . have helped build the 48-year-old Spicer reputation for the highest standard of automotive power transmission equipment in the industry.

Spicer

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The World's First Round-the-World Car

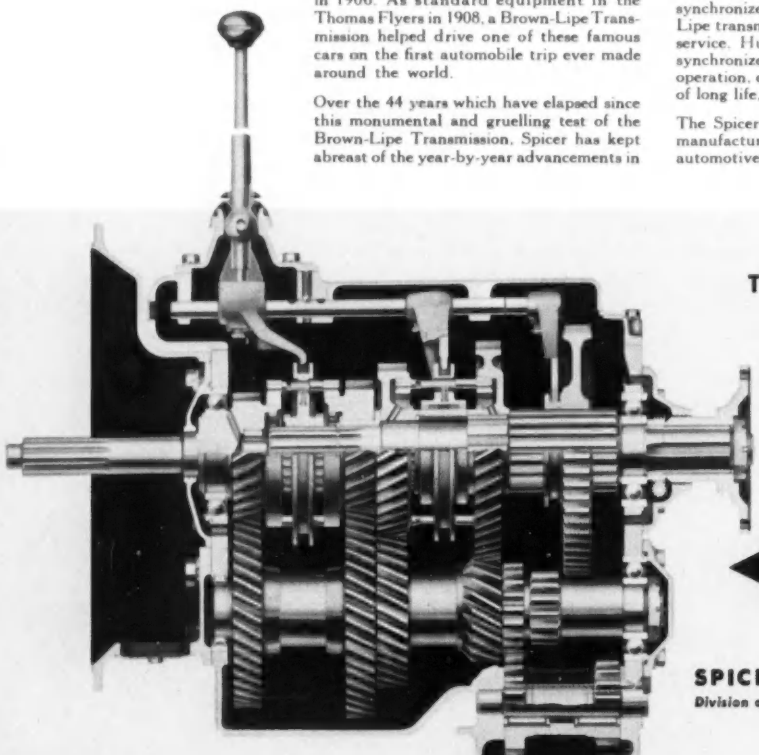
Equipped with a Brown-Lipe Transmission built in the Spicer *Pattern of Precision!*

The first selective type automobile transmission was shipped from the Brown-Lipe factory to the E. R. Thomas Motor Company in 1906. As standard equipment in the Thomas Flyers in 1908, a Brown-Lipe Transmission helped drive one of these famous cars on the first automobile trip ever made around the world.

Over the 44 years which have elapsed since this monumental and gruelling test of the Brown-Lipe Transmission, Spicer has kept abreast of the year-by-year advancements in precision control, to constantly maintain its enviable record of quality production.

Within the last 20 years, Spicer has adapted its synchronized gear-shift principles to Brown-Lipe transmissions for rugged truck and bus service. Hundreds of thousands of these synchronized units now are in heavy-duty operation, establishing outstanding records of long life, economy, and ease of operation.

The Spicer *Pattern of Precision* in every manufacturing step pays off in every Spicer automotive power transmission unit.



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stems from pressure from three sources: essential economies, higher compression ratios and increased supply of LPG itself.

These were the opening remarks of one of the two speakers, **Leonard Raymond,** staff engineer, Socony Vacuum Co., at the January meeting.

The independent bus operator's position has become fairly serious in the squeeze between rising labor and other costs and continued fare difficulties, Leonard said. The availability of engines of higher compression ratio to use high octane number propane makes it possible to improve the fuel economy with this lower energy material. The increased supply of LPG arises from the tremendous expansion of the natural gas industry and the increasing insistence of state regulatory bodies, such as the Texas Railroad Commission, and the oil industry itself that loss of light hydrocarbons by flaring must be eliminated as being detrimental to conservation of our resources and economic waste.

Historically, Liquefied Petroleum Gas was first produced from refinery natural gasoline in 1910 and the first trial uses in industrial, domestic and automotive applications were made shortly thereafter. The LPG industry grew very slowly until the late thirties when a marked upswing in domestic sales began, followed by expansion of other uses. The rate of growth since 1935 has been very large, averaging 26% per year. LPG sales in 1950 totaled $3\frac{1}{2}$ billion gallons compared to 43 billion gallons of motor gasoline.

Due to the high volatility or vapor pressure of propane, in order for the material to be handled as a liquid, which is desirable from the standpoint of equipment size and economics, it must be maintained under pressure during all phases of its handling, Leonard told the group. This includes its storage at point of manufacture, its transportation by tank car or transport truck, its storage by the user, and its final use in the vehicle fuel tank and part of the fuel system.

The user's or operator's storage facilites can be either above or below ground, above ground being preferred due to reduced corrosion, ease of inspection and lower cost. Storage and vehicle tanks for commercial propane must have a minimum design working pressure of 250 psi, equivalent to a hydrostatic test of 1000 lb.

The heart of the propane fuel system is the converter and carburetor.

The gas carburetor differs from the gasoline unit since propane is supplied as a gas. The gas is drawn into the carburetor by engine suction, the carburetor and final pressure regulator being coordinated in design so as to produce control of air-fuel ratios over a range of operating conditons. An air-fuel ratio of about 13:1 is recommended for fuel load and between 14 and 14:5 for part load. Starting is facilitated by a special chock arrangement for both the air and gas passages.

Since propane enters the manifold

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A detailed application and engineering folder, No. SC-6002, will be sent on request.

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PS-1301MT Thixotropic, flow-resistant compound.
PS-1301 Low adhesion, cream deer sealant.
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as a gas the advantage of the latent heat of vaporization of gasoline in reducing mixture temperature is lost. For this and other reasons, if we install the propane converter and carburetor without other change, a loss in volumetric efficiency and power output of as much as 5% may result. A considerable part can be recovered by replacing the standard gasoline manifold and hot spot with a special cold manifold.

Propane and butane have much higher octane numbers than current regular grade gasolines and make knock-free operation at higher compression ratios possible with consequent increase in power output.

There is not very much information available on maintenance of propane-powered buses due to insufficient mileage and experience with the new units.

The availability of LPG varies with each area and company, Leonard said. While propane is plentiful in the Southwest, it is in undersupply in the East, the available supply of refinery propane there being committed to the more profitable industrial, utility and bottled gas markets with no excess for automotive use. Undoubtedly the availability of propane is largely a matter of price, and its production by refineries can be increased considerably if the price is sufficient to encourage such action. However, any such increases in price would obviously reduce the differential from gasoline and make the product less attractive to the operator.

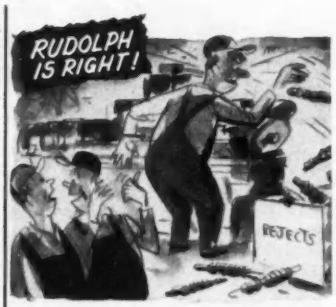
With regard to legal and safety aspects, many states and municipalities have adopted the recommendations of Pamphlet 58 in their entirety or with some modifications, generally in the direction of greater severity. A number of communities prohibit storage of LPG within the city limits, and the movement of LPG transports is restricted to certain routes and times.

The question period on this subject emphasized that for a considerable time to come New England states could not anticipate the use of LPG as a motor fuel because of the geographical relationship with the source of supply, and apparent difficulty in conforming with the present fire, safety and insurance laws.

D. S. Webber, vice-chairman of Meetings and Programs, introduced the second speaker of the evening, **Norman Hoertz**, chief engineer, service division, Thompson Products, Inc. The topic was basic maintenance problems for valves in automotive and diesel engines. This talk, like the one of the previous speaker, was illustrated by the use of lantern slides.

An emphatic need for precision and accurate checking and adjusting of valve lash was reiterated by Hoertz. Insufficient valve lash will greatly reduce the efficient life of any engine while excessive valve lash is responsible in most cases for broken valves and the resultant damage to the engine.

Replacement of worn or damaged valve springs does not necessarily re-



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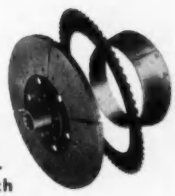

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store the springs to their original required tension. Worn spring cups or wear in the casting around the outside of the valve guide should be compensated for. In some cases a thick steel washer can be used. The depth of the valve in the seat caused by grinding should also be compensated in a like manner.

Valve seats should be deep, rather than shallow, when the need for replacing takes place, since the former is less subject to warping than the latter. Uneven cooling, created by certain cylinder casting designs where the water jacket does not extend completely around valve seat, is to some degree responsible for this condition and is more acute in the case of the installation of narrow seats. This seat movement varies from 8 thousandths to 20 thousandths of an inch, Hoertz said.

If there is a choice of hardness in the material of the valve seats, such as Stellite, then the latter should be used for installation, since a much longer life can be expected with the latter over hard iron seats. Worn tappets or rocker arms should be repaired or replaced; otherwise correct tolerances cannot be maintained and short engine life is usually the result.

Sodium-cooled valves normally reduce operating temperatures by about 200 F and extended motor life is the expected result, so that when they are available as a service item the net result is justification for the increased cost. The latest innovation in the valve train towards the conservation of parts and extended motor life is valve rotators. These rotators are known by various trade names and are generally classified as positive type and release type. The extended life of valves with this type of installation is from two to five times and in frequent cases ten times more.

The reasons for this are:

A. Valve face and seat are constantly wiped clean—no build-up of deposits to flake off and start valve guttering.

B. Stem deposits which cause valves to stick in their guides and to be held open are prevented.

C. Effects of distortion due to thermal and/or mechanical factors are minimized.

D. Local hot spots that cause burning are prevented.

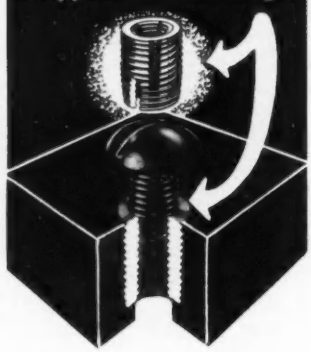
E. The valve tip is prevented from grooving due to rocker arm scrubbing.

F. More uniform stem lubrication is provided, and acts to prevent scuffing.

A letter from Harry Stanton who was in Detroit was read by Dave S. Webber. Stanton, who is automotive engineering editor for the Boston Globe, is representing Lewis B. Ebbs, chairman of the New England Section, at the Annual SAE Meeting. Harry's chief mission is to convince the meetings committee that the national transportation meeting for 1954 should be held in Boston. Lew Ebbs stated that such an adventure has the backing of the Boston Chamber of Commerce.

TAP-LOK INSERTS

for original installations and stripped thread salvage



Tapped threads that strip easily are a headache to customers. Thread failure in light metals, plastics and similar materials can be prevented by the Tap-Lok Insert, a hard steel bushing that increases the shear area.

These Inserts are widely used for original installation because, being self-tapping, they save many manhours in assembly. They are quickly installed with a simple driving tool into a cored or drilled hole equal in size to a tap drill hole for the external thread of the Insert. They hold rigidly in position and do not become loosened when the male part of the fastening is removed.

The Inserts are also extensively used for the salvage of threads stripped in assembly. Many manufacturers are using them for this purpose to reduce the high cost of rejects.

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Continued on Page 122

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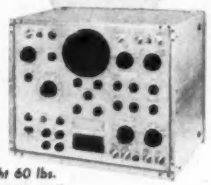

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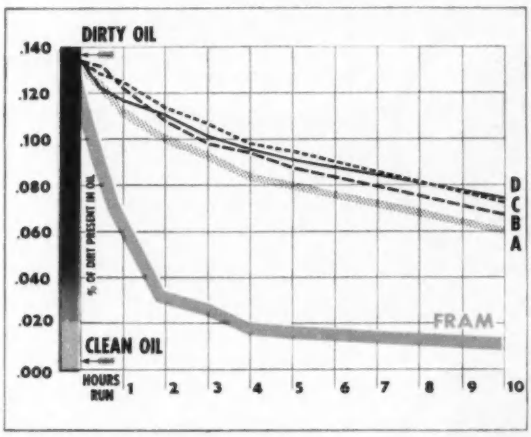

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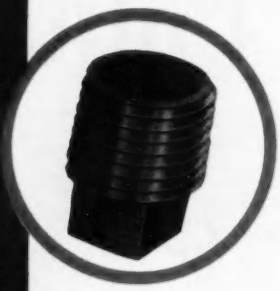

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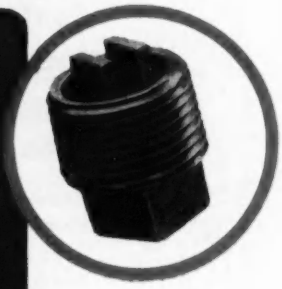

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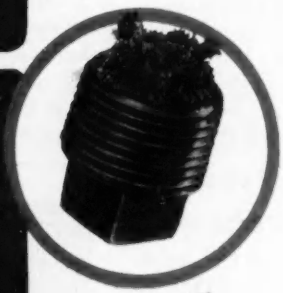

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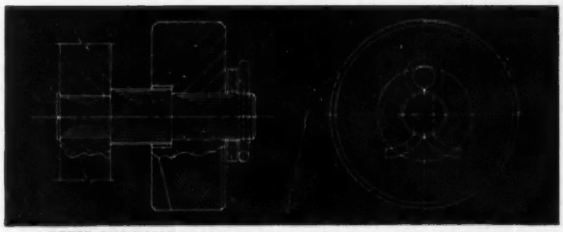
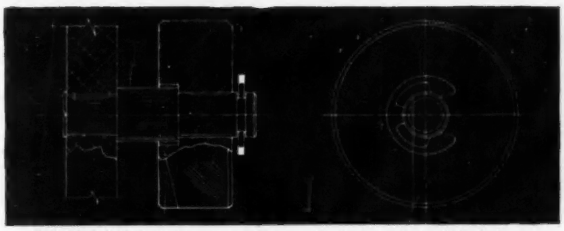
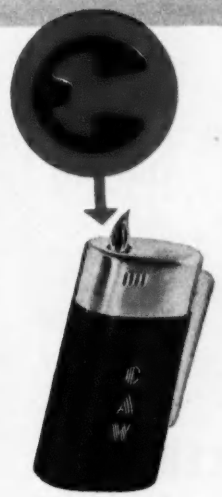


COTTER PIN WAY: Flint wheel shaft in lighter assembly requires cotter pin, washer. Difficulty in drilling perfect hole causes rejects. Assembly is slow, costly.



TRUARC WAY: Waldes Truarc "E" ring fits into groove in shaft; locks assembly securely for life. Groove is quickly, easily cut... assembly is simple, speedy.



Brown & Bigelow, St. Paul, Minn., saved *$6.95 per thousand units* by incorporating Truarc Rings in the design for the REDI-FLAME compressed gas desk lighter! In spite of greater initial cost of Truarc Rings as against cotter pins, they were able to cut machining and assembly costs drastically—for an overall savings of 44%!

Redesign with Waldes Truarc Rings and you too will cut costs. Wherever you have a fastening problem...wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Truarc Ring designed to do a better job of holding parts together.

Waldes Truarc Rings are precision-engineered...quick and easy to assemble and disassemble. They can be used over and over again.

Find out what Truarc Rings can do for you. Send your blueprints to Waldes Truarc engineers for individual attention, without obligation.

COMPARATIVE COSTS

Cotter Pin Way		Truarc Way	
Material	*$ Per M*	*Material*	*$ Per M*
Shaft	.48	Shaft	.35
Cotter pin	.46	Truarc ring	8.68
Washer	1.50		
	2.44		9.03
Labor		*Labor*	
Shaft	10.22	Shaft	2.27
Washer	.72		
Assembly	9.28	Assembly	4.41
	20.22		6.68
TOTAL	$22.66	TOTAL	$15.71

TOTAL SAVINGS WITH TRUARC RINGS: $6.95 or 44%

For precision internal grooving and undercutting... Waldes Grooving Tool.

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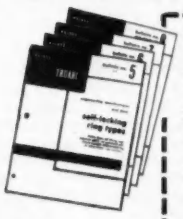

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WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS: 2,302,967; 2,302,968; 2,410,852; 2,420,021; 2,428,341; 2,439,785; 2,441,868; 2,455,165; 2,493,300; 2,493,383; 2,467,802; 2,487,803; 2,491,308; 2,500,081 AND OTHER PATENTS PENDING.

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Please send engineering specifications and data on Waldes Truarc Retaining Ring types checked below. SA-024

- ☐ Bulletin #5 Self-locking ring types
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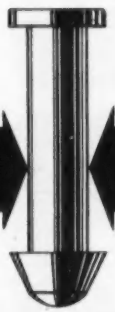
A REMINDER TO DESIGN & STRESS ENGINEERS

the hi-shear HS-27 flush head HS-28 flat head



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DASH NUMBER	DIAMETER
— 6	.1894
— 8	.2492
—10	.3117
—12	.3742
—14	.4367
—16	.4991
—18	.5616
—20	.6240

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LOS ANGELES, CALIF.

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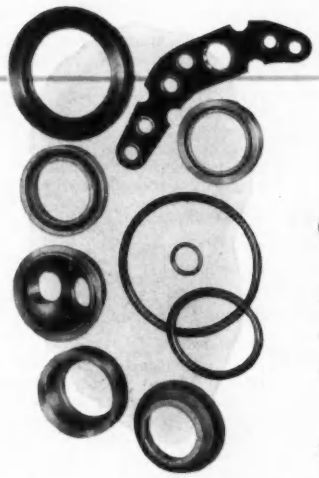
Educated at Worcester Polytechnic Institute, Mr. Clark met his first packings problems as a designer and manufacturer of precision instruments. With Graton & Knight Company since 1935, he has been factory worker, foreman, sales correspondent, sales engineer, sales manager and finally General Manager of the Packings Division. He wrote the 320-page Graton & Knight Packings Manual, which has been adopted as a text book in many of the technical schools and colleges. A member of the Standards Committee of the American Leather Belting Association, he is now at work on the standardization and simplification of packings through the Joint Industry Conference.



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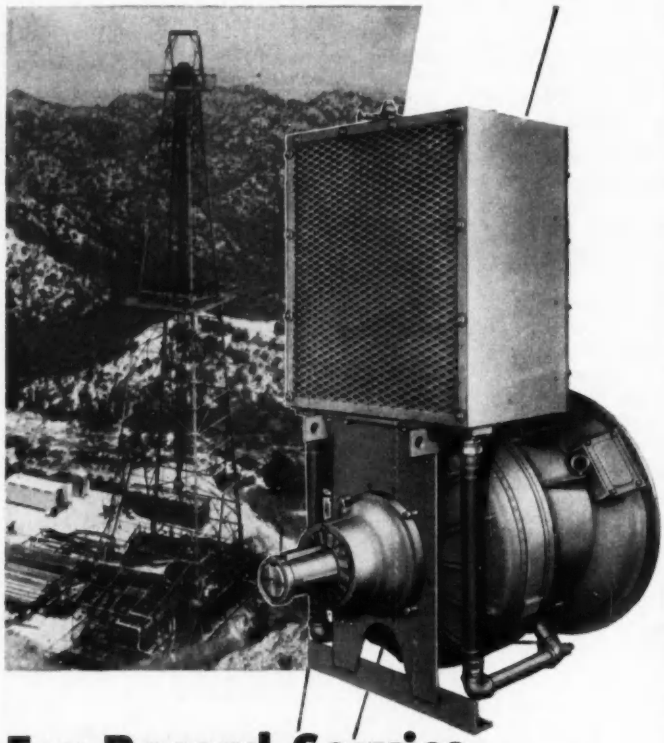

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And you can expect real performance, too. For three of these same Twin Disc converters are on the rig which drilled 3500 feet in 24 hours . . . a record in the California field . . . and later came out of the hole from approximately 9000 feet in 114 minutes.

In California or in every field the world over, you'll find Twin Disc Hydraulic Torque Converters the choice of leading drillers because these men know Twin Disc offers the best in converter wear-life, the best in rig wear-life, and the best in performance. Write today for Bulletin 135-D, Twin Disc's *new* literature on torque converters.

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Kansas City Section

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Continued on Page 128

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Williamsport Group

Elbert Brunner Reynolds, Jr., Charles E. Wilkinson.

Outside of Section Territory

William E. Dunn, Jr., Edward Horton Fletcher, Loren H. Norby, H. Vernon Seymour.

Foreign

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Where Pressure Lubricating Systems are Employed— Dependable Oil Seal Performance is a Must

Many machinery manufacturers are adopting pressure lubricating systems in their new designs. This method of lubrication insures longer trouble-free performance, reduces maintenance costs and eliminates shut-down time ordinarily required for periodic manual greasing.

The new Emsco "GB-800" oil field drilling rig is a fine example of heavy equipment which employs pressure lubrication. In this new unit more than 25 oil seals are employed on shafts ranging in size from 1½ to 10 inches. As shown in the photo of the drawworks (Fig. 1), three engines, transmission and hoist are mounted on a common skid and can be transported as a unit. The cut-away drawing (Fig. 2) is of the main hoist drum shaft assembly. The pressure lubricating system is piped to bearings on the main shaft and in the idler sprocket. Oil flows through the bearing assembly flushing out all dirt or other foreign matter.

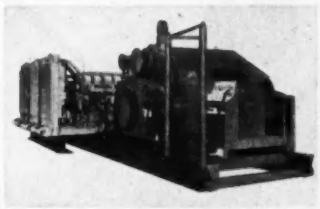

Fig. 1—New Emsco "GB-800" skid-mounted rig for portable derrick operation

National leather sealing members are specially treated to retain their shape and maintain an effective seal when subjected to such extraordinary operating conditions. These same type National leather seals have established performance records in many heavy duty applications on shafts up to three feet in diameter.

If you are working on a design for heavy duty equipment, remember: National Oil Seals are, daily, establishing performance records. The seals you need are probably listed among National standard designs already in production for you. Investigate and see for yourself. No cost or obligation, of course.

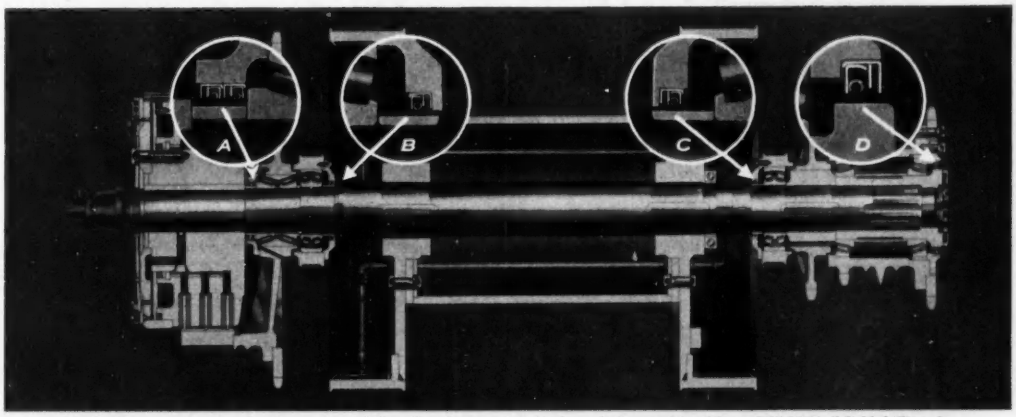

Fig. 2—Cut-away drawing showing position of five oil seals on main hoist drum shaft assembly of Emsco "GB-800" oil field drilling rig

In this drum shaft section, five single-lip, spring-loaded National 50,000 series seals (Fig. 3) are employed. Near the clutch position (A) two of these seals are mounted in tandem to provide protection against leakage into the clutch. The lubricating system places the relatively large oil seals under a constant internal pressure. The equipment is also subjected to frequent reversing and heavy load shocks resulting in a strenuous heavy duty sealing problem.

Fig. 3—National 50,000 series leather oil seal

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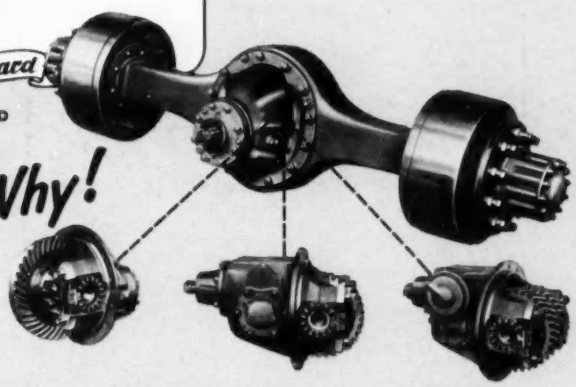

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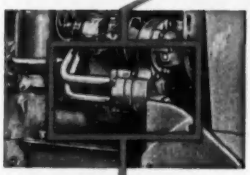
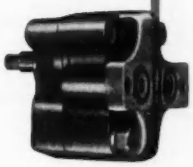




Small, compact, weighing only 3 lbs. Pesco hydraulic pump Model 051012 operates at 1200 psi and will pump 4½ gal. per minute at 2800 rpm.

For rugged, dependable duty in the fields, the powerful Farmall Super C tractor is equipped with a Pesco hydraulic pump. This pump powers the hydraulic system that gives complete finger-tip control of the tillage tools . . . control that makes farm work easier . . . lessens time spent in the fields. International Harvester uses smooth Pesco hydraulic power to do the heavy work on Farmall Cub, Super A and Super C. This is because Pesco hydraulic engineers have developed hydraulic pumps that give top-flight performance with little or no maintenance.

Perhaps Pesco equipment can help your products give the dependable service that wins customer loyalty. Why not write today for full information?

engineering Pesco production

PRODUCTS DIVISION

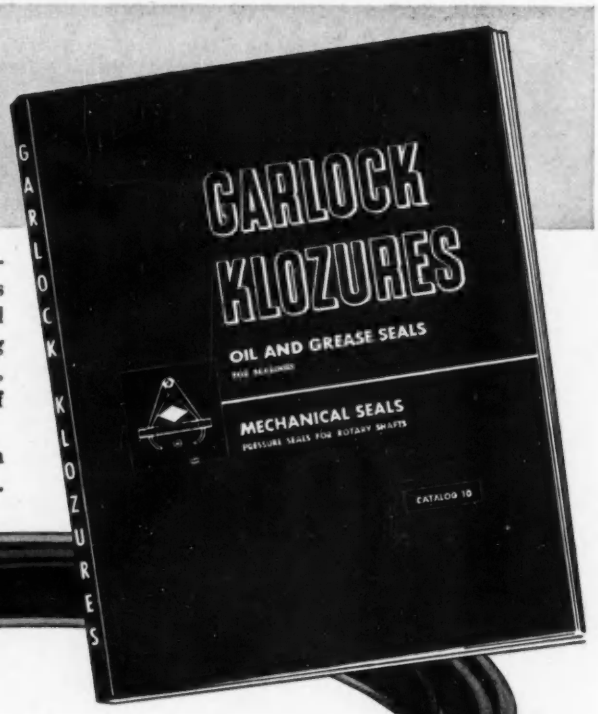
BORG-WARNER CORPORATION

24700 NORTH MILES ROAD BEDFORD, OHIO

WRITE FOR YOUR COPY!

This new handy catalog describes our *complete* line of KLOZURE Oil and Grease Seals for bearings. It contains illustrations of all the types of KLOZURE Oil Seals—including many new designs for bearing protection, typical applications, and a complete list of sizes and part numbers.

In addition, this catalog also describes in detail Mechanical Seals for rotary shafts.



THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK
In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.

GARLOCK *Klozure* OIL SEAL
*Reg. U.S. Pat. Off.

Mail this coupon today!

SAE-2-52

THE GARLOCK PACKING CO.
PALMYRA, N. Y.

Please send me a copy of the new Garlock KLOZURE Catalog No. 10

Name .....
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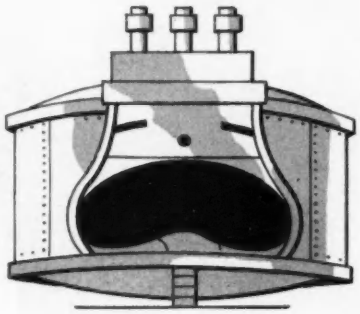
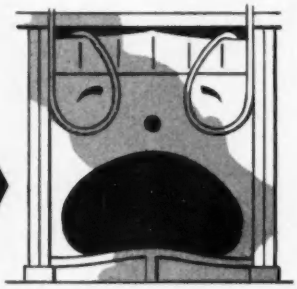
THE WALLACE BARNES COMPANY LTD.
HAMILTON, ONT. CANADA

Help feed these hungry mouths!

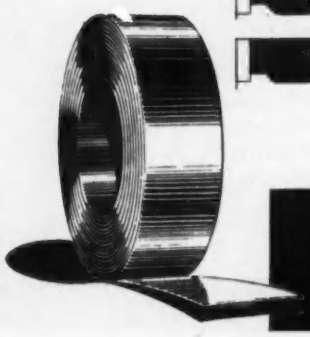




The steel industry NEEDS your scrap to help supply YOUR needs in STEEL

ROOT OUT THE SCRAP TODAY

ROUTE IT ON ITS WAY!

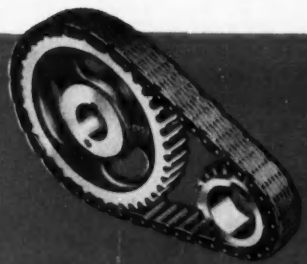


Superior Steel
CORPORATION
CARNEGIE PENNSYLVANIA

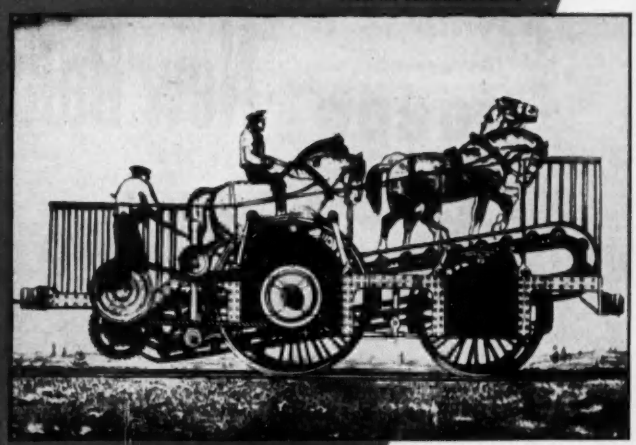
M-TC

Morse *means* Timing Chains

SINCE 1916, fifty-four million precision-built Morse Timing Chains have been specified as original equipment on as many passenger cars and trucks. Each timing chain has been a credit to Morse's close cooperation with the automotive industry and Morse's unassailable leadership in the manufacture of automotive timing chains.



From the Bettmann Archive



The idea behind this sketch of a horse-powered locomotive, whatever its shortcomings, was at least another step toward today's highly developed means of transportation. As more efficient means of propulsion were introduced, Morse Chains were there, matching development for development, to add their efficiency and smoother operation in the transmission of power.

This is one of a series of old prints of old machines (and ways of power transmission) that will appear in future Morse advertisements. Write for your free, enlarged copy, suitable for framing for your collection.

MORSE CHAIN COMPANY

Dept. 275 • 7601 Central Avenue • Detroit 10, Michigan

MORSE

MECHANICAL

POWER TRANSMISSION

PRODUCTS

PRODUCTS OF BW BORG-WARNER

New Balanced-Alloy Steels

80B00
TS8100
81B00
TS8600
TS94B00
4100 INT

The new series of balanced-alloy steels recently approved by the American Iron and Steel Institute are now being made by Bethlehem.

They are designed primarily to save nickel and molybdenum that are urgently needed for certain defense applications.

The new balanced-alloy steels are being used to replace some of the older and better known alloy grades such as: 2300 Nickel, 3100 Nickel-Chromium, 4100 Chromium-Molybdenum, 4600 Nickel-Molybdenum, 8600 and 8700 Nickel-Chromium-Molybdenum steels.

If you have any problems concerning the use of the new balanced-alloy steels, or if you need information on the selection, treatment and machining of steels for defense work, our metallurgists will be glad to help. Phone or write for this service.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

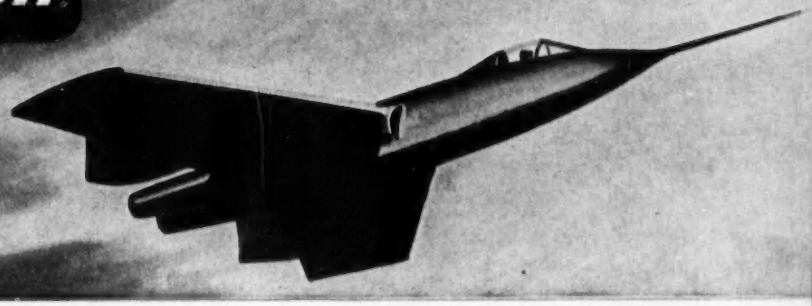
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM ALLOY STEELS

BETHLEHEM STEEL

Bendix Products Division

FIRST IN FUEL METERING



Where Today's Ideas Become Tomorrow's Achievements

America's world leadership in aviation is due largely to the industry's ability to convert dreams into realities—to apply creative engineering to the solution of every new problem.

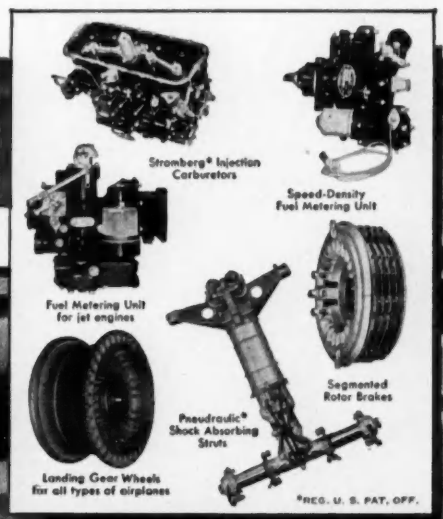
The Bendix Products Division of Bendix Aviation Corporation is proud of the part it has been able to play in meeting this challenge of constant product improvement. And Bendix Products pledges its knowledge and resources to a continuation of this program of progress so essential to world leadership.

If the Bendix Products combination of creative engineering and quality production can assist you in the development of carburetion, fuel metering, struts, brakes or wheels—just let us know. Your inquiry will receive prompt attention.

BENDIX · PRODUCTS DIVISION · SOUTH BEND Aviation Corporation

Export Sales: Bendix International Division, 72 Fifth Ave., New York 11, N. Y.

LEADER IN LANDING GEAR


Stromberg* Injection Carburetors
Speed-Density Fuel Metering Unit
Fuel Metering Unit for jet engines
Segmented Rotor Brakes
Pneudraulic* Shock Absorbing Struts
Landing Gear Wheels for all types of airplanes
*REG. U. S. PAT. OFF.

Friction material problem?

R/M BELONGS IN YOUR PICTURE!

"STOP-AND-GO" IS OUR BUSINESS!

Maybe you don't make over-the-road haulers... but *whatever* your problems in brakes and clutches, you can count on RAYBESTOS-MANHATTAN for specialized friction materials that will give you the same good results heavy-truck-builders get from *their* R/M products.

More cars, trucks and buses now use R/M brake linings, clutch facings, and automatic transmission friction parts than any other make. And R/M's leadership in these products extends to scores of other fields, from farm equipment to musical instruments.

You'll be a step ahead when you call in your R/M representative. He's ready to help you . . . and he can work from samples, from designs on paper, or from figures on horsepower developed, combined with desired performance characteristics. Behind him stand the facilities of the world's largest producers of friction materials, with six great plants . . . their research departments, and their testing laboratories.

The recent opening of our new Wabash Division, Crawfordsville, Ind., provides expanded facilities for the manufacture of SINTERED METAL FRICTION MATERIALS

R/M
FIRST IN FRICTION

RAYBESTOS-MANHATTAN, INC.

EQUIPMENT SALES DIVISION **620 Fisher Bldg., Detroit 2, Mich.**
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Factories: **Bridgeport, Conn.** **Manheim, Pa.** **Passaic, N.J.** **No. Charleston, S.C.**
Crawfordsville, Ind. **Canadian Raybestos Co. Ltd., Peterborough, Ont.**

RAYBESTOS-MANHATTAN, INC., Manufacturers of Brake Linings • Brake Blocks • Clutch Facings Fan Belts • Radiator Hose • Mechanical Rubber Products • Rubber Covered Equipment • Packings Asbestos Textiles • Sintered Metal Products • Abrasive and Diamond Wheels • Bowling Balls

R/M

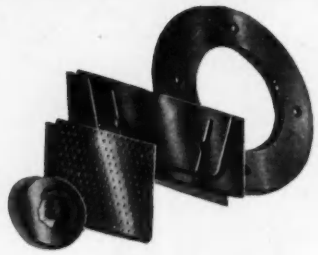
JOHNSON BRONZE
SLEEVE BEARING DATA

Bearing TYPES

JOHNSON BRONZE
SLEEVE BEARING DATA

Sheet Metal Bearings-2

Pre-Cast Bronze-on-Steel



WHILE this is a comparatively new type of bearing material, developed and patented by Johnson Bronze, millions of bearings and parts now in constant use provide definite proof of its excellent qualities.

Pre-Cast Bearing BRONZE-ON-STEEL is essentially a thin wall, laminated type of bearing that combines the bearing qualities of a high grade bronze alloy with the strength of steel. We start with a mixture of copper, tin and lead which is universally accepted as the best general purpose bearing bronze available. It combines, in the correct proportion, all the necessary elements to insure the utmost in bearing performance.

By casting this alloy in solid bronze bars we unite the metals chemically and form a definite copper-tin eutectic—with the lead trapped in the interstices. Thus the grain structure of the alloy—and the resulting bearings—is definitely established. Next, we reduce the bronze bar to a fine powder, about the same consistency as talcum. This powdered bronze is then treated in a hydrogen furnace to remove all oxides and then firmly bonded to copper coated strip steel. The process of manufacturing bearings from BRONZE-ON-STEEL, in strip form, is the same as for any other type of sheet metal bearing, being essentially a stamping and forming operation.

Bearings are made from this material in the same manner as bronze sheet metal bushings. The range of wall thickness is between .031" to .110". Lengths of bearings cannot exceed 4½". The smallest I.D. which can be formed is ⅜". Steel thickness for .052" wall bushings is .036"; for .070" wall it is .050" thick.

BRONZE-ON-STEEL is assembled by the same methods ordinarily used for bronze metal. It can be burnished with ordinary tools. It is also possible to bore and ream this material, but special carbide tipped tools are necessary. Diamond boring is sometimes recommended as a finishing operation.

Chemical and Physical Properties of Bronze-on-Steel

CHEMICAL ANALYSIS	Plain Bronze	Graphited Bronze
Copper	Balance	Balance
Tin	8-11	8-11
Lead	8-11	8-11
Graphite	none	1.0 max.

PHYSICAL PROPERTIES

	(1) Rockwell Hardness E Scale	(2) Wear Rate	(3) Coefficient of Friction	(4) Resistance to Pounding	(5) Resistance to Pounding
Plain Bronze	55 min.	0.09	0.14	64	447
Graphited	55 min.	0.02	0.13	57	255

1. Rockwell Hardness, E scale 100 Kg. Load—⅛" ball.
2. Wear Rate Loss of weight in grams—1 hour run, 1" I.D. bushing at 400 R.P.M.—.005" clearance—25 lb. per sq. in. pressure—no lubrication.
3. Coefficient of Friction—as determined on J. B. Machine. No lubrication.
4. Resistance to pounding—number of blows of 60 lb. hammer falling 2" to deform specimen .001"—1" x 1" x 1/16" specimen.
5. Same as (4) with deformation going to .005".

Specifications

	Standard Wall Thickness	For Shaft Diameters
1.	.032—.035	From 5/16" to 1½" Shaft
2.	.042—.045	From ⅜" to 1¾" Shaft
3.	.062—.065	From ⅝" to 2¾" Shaft
4.	.092—.095	Over 1¼" Shaft

In order to obtain the best results from Pre-Cast Bearing BRONZE-ON-STEEL bushings and bearings, it is advisable to include the following information in your specifications:

1. SIZE of hole bushing is to be pressed into—rather than O.D. of bushings.
2. SIZE I.D. required after pressing into place. Manufacturers standard tolerance .002.
3. TYPE of body or housing bushing is pressed into.
4. SPECIAL FEATURES of bushing should be fully explained including their purpose.

Thrust Washers

While BRONZE-ON-STEEL was developed primarily for Bushings and Bearings it also fills many other important industrial uses. It is ideal for applications requiring a flat bearing surface such as plates, washers, etc.

Some manufacturers prefer to purchase BRONZE-ON-STEEL in rolls and do their own stamping and forming. For such cases we can furnish it in rolls up to 400 feet in length. The maximum width of the strip cannot exceed 6½ inches.

●

This bearing data sheet is but one of a series. You can get the complete set by writing to—

Johnson Bronze

SLEEVE BEARING HEADQUARTERS
675 S. MILL ST. • NEW CASTLE, PENNA.

STERLING
PISTONS

Contributing to Better Engine Performance for Over 30 Years

Sterling Engineers will work with you as they have with other leading manufacturers in developing pistons to meet your exacting requirements. Write or phone.

Cut PRODUCTION TIME . . . COSTS . . . FAILURES!

It's a CINCH

WITH Standard X-WASHERS

● Every manufacturer knows inefficient production methods eat up profits.

STANDARD X-WASHERS help *cinch* them. They cut production time . . . production costs . . . and eliminate consumer kick-backs, because they strengthen the construction of your product. That's why designers for profit-minded manufacturers in all parts of the country are specifying this ideal fastener.

An ordinary pair of pliers quickly and easily cinches STANDARD X-WASHERS to a positive 360° closure—*and* removes them for servicing just as easily.

Check your fastener needs. Chances are you, too, can help cinch bigger profits by switching to STANDARD X-WASHERS—the modern fastener designed for modern assembly methods.

Write for STANDARD'S detailed bulletin, today!

Grooved pins are made available for all sizes of STANDARD X-WASHERS . . . parallel or headed type pins made to your specifications. Send your print for a prompt quotation.

STANDARD Locknut and Lockwasher, Inc.
510 NORTH CAPITOL AVE. • INDIANAPOLIS 4, INDIANA

Basic Bearing Refinements

CUT TRUCK MAINTENANCE!

Fundamentally, America's truck owners buy ton-miles! And they want them at the lowest possible cost! That's why wise truck manufacturers who realize the importance of precision-built bearings to dependable truck performance standardize on Bower *Spher-O-Honed* bearings. Basic bearing refinements—mirror-smooth finish, generous oil groove, millionth-inch tolerances—are only a few of the many important Bower features. They are specifically designed to reduce maintenance to a practical minimum—add mile upon mile to the life of the bearings. Whatever your product, if it uses bearings you'll be wise to equip it with longer-lasting Bower *Spher-O-Honed* bearings.

BOWER ROLLER BEARING COMPANY
Detroit 14, Michigan

BOWER

SPHER-O-HONED

ROLLER BEARINGS

Velvet smooth performance

Long torque converters offer the automotive manufacturer important advantages in design, performance and cost.

Power transfer is smooth—*dependably* smooth—torque multiplication of better than 2 to 1 at stall. The converter is direct air-cooled for simplicity and trouble-free service.

Assembly units are fabricated almost entirely from stampings, for low-cost manufacture.

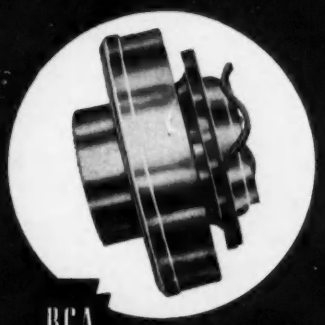
LONG MANUFACTURING DIVISION
Borg-Warner Corporation
DETROIT 12, and WINDSOR, ONT.

ENGINEERING B-W PRODUCTION

LONG
CLUTCHES • RADIATORS • TORQUE CONVERTERS
OIL COOLERS

Wherever "Specs" call for DEPENDABILITY...

BCA BEARINGS are the standard



The U. S. Army Ordnance Corps' "Eager Beaver" is a truck that has weathered the worst—deep water, mud, heat, cold, dust, steep grades, rocky roads.

Built by Reo to specifications that are really tough, every part of these trucks was selected to withstand the most severe kind of beating. That's why BCA Bearings "or equal" were specified by the Spicer Division of Dana Corp., suppliers of the transmissions and clutches.

BCA Bearings are *performance proved*. They have an enviable record for dependability, economy and long-life . . . they are original equipment on many trucks, buses, cars and tractors . . . they are the *first choice* of design engineers with critical specifications.

Whatever your bearing requirements — transmission, clutch, differential, wheels, generators — specify the best . . . BCA Bearings.

BCA

BEARINGS COMPANY OF AMERICA
LANCASTER, PA.

Makers of a complete line of Ball Bearings for all makes of cars, trucks, buses and tractors.

Candidates of Character
Sealed Power Piston Rings, Pistons, and
Cylinder Sleeves have been voted back into office year after year
—strictly on a basis of performance. They are candidates
for consideration wherever character counts. Forty years of leadership have
made today's Sealed Power facilities and staff the finest
in our history. Use them to help make your good
engines even better.
SEALED POWER CORPORATION
MUSKEGON, MICHIGAN
SEALED POWER
PISTON RINGS
Sealed Power
PISTON RINGS · PISTONS
CYLINDER SLEEVES

In a class by itself is the Clark Housing—a one-piece forging, heat-treated. Its presence is clinching proof of a quality-built vehicle.

It's good business to Work with Clark.

SEE NEXT PAGE FOR MORE ABOUT CLARK PRODUCTS

CLARK EQUIPMENT COMPANY, Buchanan, Michigan

Other Plants: BATTLE CREEK AND JACKSON, MICHIGAN

SEE MANPOWER DELIVER MORE POWER by means of CLARK YARDLIFTS

YOU'LL MAKE THE MOST OF MANPOWER

BY MAKING MAN-POWER MORE PRODUCTIVE through use of Clark Yardlift fork trucks—pneumatic-tired huskies designed especially for outdoor handling of heavy, bulky loads. Fast, easy to maneuver and safe, these machines possess amazing stability in operation over rough surfaces. Three capacities—2,000, 4,000 and 6,000 pounds.

CLARK ELECTRIC AND GAS POWERED **FORK TRUCKS**
AND POWERED HAND TRUCKS • INDUSTRIAL TOWING TRACTORS

INDUSTRIAL TRUCK DIVISION • CLARK EQUIPMENT COMPANY • BATTLE CREEK 12, MICH.
Please send: ☐ Material Handling News ☐ Condensed Catalog
Name_____
Firm Name_____
Street_____
City_____ Zone____ State_____

The field of Materials Handling offers Industry its richest opportunities for increased productive capacity, improved efficiency, better employee relations—and substantial cash savings . . . And the ideal tools with which to achieve those benefits are the Clark Yardlifts and other machines and special devices that constitute the *Leadership Line*.

PRODUCTS OF CLARK—TRANSMISSIONS • FORK TRUCKS & TRACTORS • AXLE HOUSINGS • GEARS AND FORGINGS • RAILWAY CAR TRUCKS • ELECTRIC STEEL CASTINGS • AXLES • TRACTOR UNITS

"Our 350 units get rugged service...

their fine performance wouldn't be possible except with

Wagner Air Brakes"

users are our biggest boosters

MODERN EQUIPMENT • DEPENDABLE • BONDED

DECATUR CARTAGE COMPANY

TWENTIETH STREET AND WENTWORTH AVENUE — Chicago 16

August 20, 1951

Wagner Electric Corporation
2411 S. South Park
Chicago, Illinois

Gentlemen:

I have just been complimenting our Maintenance Department on the fine performance of our tractors and they told me, very bluntly, that it was about time we complimented Wagner Electric Corporation on their Air Brakes. We haven't had a single case of road failure because of this equipment since we have been buying "Wagner"

The Rotary Air Compressor was the feature that originally sold us on trying your product and we have found these Brakes troublefree and requiring a minimum of maintenance.

Likewise, we have found your Air Brakes simple and easy to install. These features have influenced us to specify "Wagner" on any new additions to our fleet.

Our 350 units, as you well know, get rugged service and the fine performance of our trucks wouldn't be possible except with Wagner Air Brakes.

Yours very truly,

DECATUR CARTAGE COMPANY

R. A. Baensch
Executive Vice President

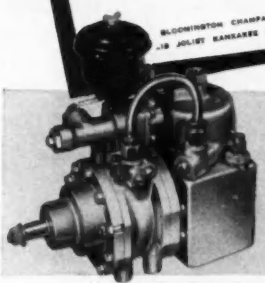
RAB:sr

BLOOMINGTON CHAMPAIGN CHICAGO CINCINNATI CLEVELAND COLUMBUS JOLIET KANKAKEE MUNCIE OTTAWA PARIS PEORIA PONTIAC QUINCY

says R. A. Baensch, Executive Vice Pres.
DECATUR CARTAGE COMPANY

You, too, will find—if you equip the vehicles you manufacture with Wagner Air Brakes—maintenance will be no problem for the users. Reason—they require less maintenance than ordinary air brakes because of such engineering achievements as the Wagner Rotary Air Compressor, and the Wagner Power Cluster. Then, too, when maintenance becomes necessary, it can be quickly and economically handled because everything in the system is of simple design. As an example—the air compressor can be disassembled, serviced and put back in a few hours.

It will pay you to investigate the many advantages of Wagner Air Brakes as standard equipment on the vehicles you are manufacturing. Write for copy of Catalog KU-201 and complete information. Coupon below is for your convenience.



used as original equipment by truck, tractor, and bus manufacturers

Wagner Products Serve the Automotive and Electrical Industries

LOCKHEED HYDRAULIC BRAKE PARTS and FLUID
NoRoL . . CoMaX BRAKE LINING . . AIR BRAKES . . TACHOGRAPHS
ELECTRIC MOTORS . . TRANSFORMERS . . INDUSTRIAL BRAKES

Wagner Electric Corporation
6378 PLYMOUTH AVE., ST. LOUIS 14, MO., U. S. A.
(Branches in principal cities in U. S. and in Canada)

NAME_____

COMPANY_____

ADDRESS_____

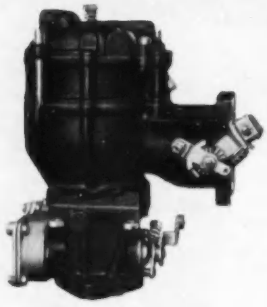
CITY_____ STATE_____

ESP-1A

Does He Knock or Boost Your Truck?

IT ALL DEPENDS
ON PERFORMANCE
and
PERFORMANCE
DEPENDS ON

Zenith
CARBURETORS



What drivers and operators say about your vehicles has a mighty important bearing on the future of your business. So it is imperative that every component be selected on the basis of its contribution to lasting, satisfactory performance. In the field of heavy duty carburetion Zenith* has long been recognized as the engineer's choice for quality performance under all operating conditions. You can be sure that manufacturers whose vehicles are Zenith equipped measure carburetor costs in lasting terms rather than initial expense. Zenith's rugged construction, strong idling, freedom from stalling and obedient response to every power demand goes a long way toward building owner good will. That's why cost conscious operators and experienced drivers prefer Zenith equipped vehicles.

*REG. U.S. PAT. OFF.

ZENITH CARBURETOR DIVISION OF
Bendix AVIATION CORPORATION
696 Hart Avenue · Detroit 14, Michigan

Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N. Y.

they're
custom-built
to fit the job!

Work boats, pleasure craft

Drilling rigs, centrifugal pumps, generator sets

Earthmovers, logging yarders and loaders

Buses and highway trucks

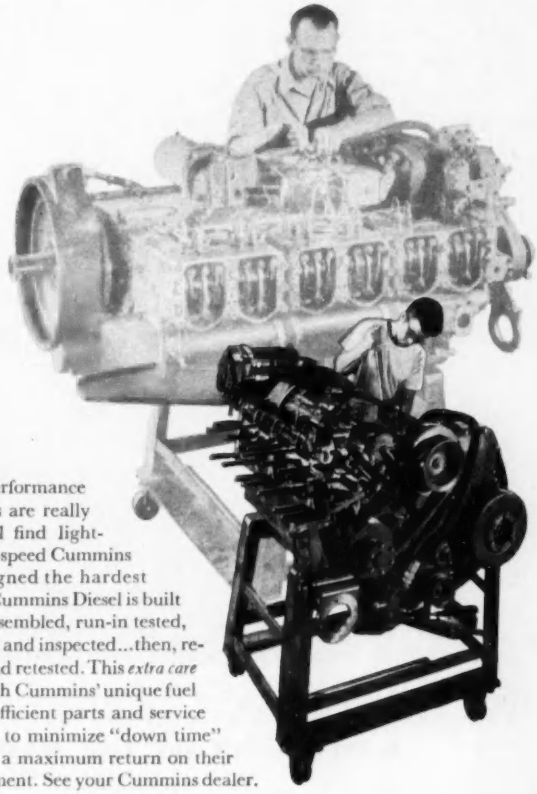
Off-highway trucks, crawler tractors

Shovels, cranes, industrial locomotives and switchers

Lightweight, high-speed Diesels (30-550 hp) for these and many other uses

Cummins® Diesels do so many jobs so much better

they're
BUILT NOT ONCE BUT TWICE



Wherever performance requirements are really rough, you'll find lightweight, high-speed Cummins Diesels assigned the hardest jobs. Every Cummins Diesel is built *TWICE*—assembled, run-in tested, disassembled and inspected...then, reassembled and retested. This *extra care* combines with Cummins' unique fuel system and efficient parts and service organization to minimize "down time" ...give users a maximum return on their diesel investment. See your Cummins dealer.

CUMMINS Dependable DIESEL

TRADEMARK REG. U.S. PAT. OFF.

Diesel power by CUMMINS

CUMMINS ENGINE COMPANY, INC., COLUMBUS, INDIANA

Export: Cummins Diesel Export Corporation • Columbus, Indiana, U.S.A. • Cable: Cumdiex

Pick a Peck of "Peashooters"

Why *only* AiResearch Oil Coolers can be serviced in the field

Peashooter-size tubes... more than 500 feet of them... are used to cool engine oil in today's high speed turbo-jet airplanes. Scientifically packed in a strong, lightweight shell, these tubes are the membrane core of the fuel-oil cooler which keeps the powerful turbine engines operating efficiently over long periods of time.

AiResearch, a pioneer in creating aircraft heat transfer equipment, designs and builds the *only oil coolers which can be serviced in the field*. Coolers are mechanically assembled so that individual tubes can be pulled out and replaced. A series of tubes can also be removed so that the cooler can be thoroughly flushed. Some units have removable cores for easy cleaning. These oil coolers meet all military specifications.

Today AiResearch manufactures 66 different types of heat exchangers to equip nearly every high speed, high altitude airplane of United States design. They include fuel-oil coolers, air-oil coolers, air-to-air heat exchangers and special equipment for cabin heating, cooling and moisture control.

Live and work in California. *AiResearch, only concern of its kind in the world, offers excellent opportunities to engineers trained in design, vibration, air conditioning, thermo-dynamics, heat transfer and development. Write today for further information.*

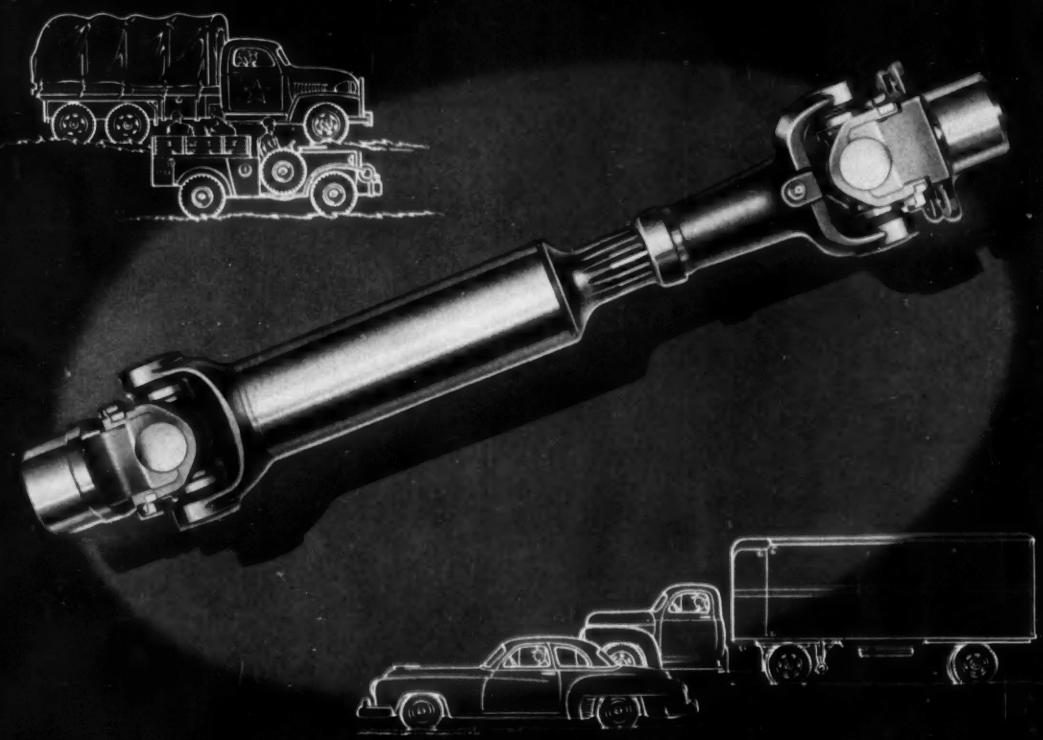
AiResearch Manufacturing Company

A DIVISION OF THE GARRETT CORPORATION

LOS ANGELES 45, CALIFORNIA

AiResearch — specialists in the design and manufacture of equipment in the following categories: Air Turbine Refrigeration • Cabin Superchargers • Gas Turbines • Pneumatic Power Units • Electronic Controls • Heat Transfer Equipment • Electric Actuators • Cabin Pressure Controls

We're Making Universal Joints for Sergeant Joe Doakes ...



... But We're Not Neglecting Civilian John Doe

It's only natural that the armed services should again take advantage of Universal Products' long experience in building quality universal joints. But meeting the requirements of military vehicles will not interfere with delivery of DETROIT Universal Joints which are needed to keep civilian cars and trucks rolling.

Detroit UNIVERSAL JOINTS

DETROIT UNIVERSAL JOINTS

UNIVERSAL PRODUCTS COMPANY, Inc., Dearborn, Michigan

Boeing B-50
power packages built by

ROHR

World's largest producer of ready-to-install power packages for airplanes

in Chula Vista, California . . . 9 miles from San Diego

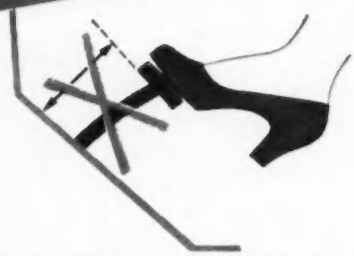
ROHR
AIRCRAFT CORPORATION

Hydraulic Power Steering for Cars . . . Trucks . . . Buses . . . Tractors . . . Earth Movers . . . Military Vehicles

Bendix Products Presents

TREADLE-VAC

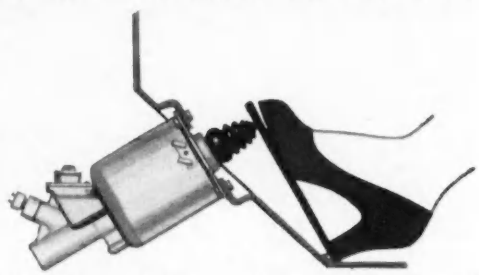
A REVOLUTIONARY ADVANCE



The old fashioned, long travel, high brake pedal requiring a lifted foot and leg power pressure can now disappear from the floor boards of modern cars.

Now passenger car manufacturers can offer braking that is comparable to the accelerator in operating ease, convenience and fatigue-saving comfort for the driver. Treadle-Vac gives an entirely new type of passenger car brake control, using the proved operating principles of the Bendix*Hydrovac,* the world's most widely used power brake. An easy ankle movement, much like working the accelerator, is all the physical force needed for normal braking. And what is equally important, the brake treadle can be on about the same level as the accelerator, so that the foot moves from one control to the other by simply pivoting on the heel. Thoroughly proved by years of testing, this latest development of Bendix engineers gives car manufacturers an opportunity to offer their customers *for the first time* the easiest, safest, and smoothest braking that can be imagined. From the standpoint of both appearance and performance, it is one of the finest new selling features available in years. Get the detailed story of this greatest advance in passenger car control since four-wheel brakes.

*REG. U. S. PAT. OFF.

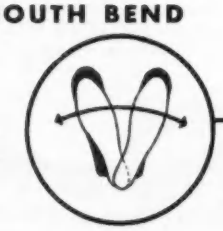


With Treadle-Vac the heel never needs to leave the floor. The low pedal, short travel and toe touch action mean that the swing from accelerator to brake can be made merely by pivoting on the heel.

BENDIX · PRODUCTS DIVISION · **SOUTH BEND**

Bendix AVIATION CORPORATION

Export Sales: Bendix International Division, 72 Fifth Ave., New York 11, N.Y. • Canadian Sales: Bendix-Eclipse of Canada, Ltd., Windsor, Ontario, Canada

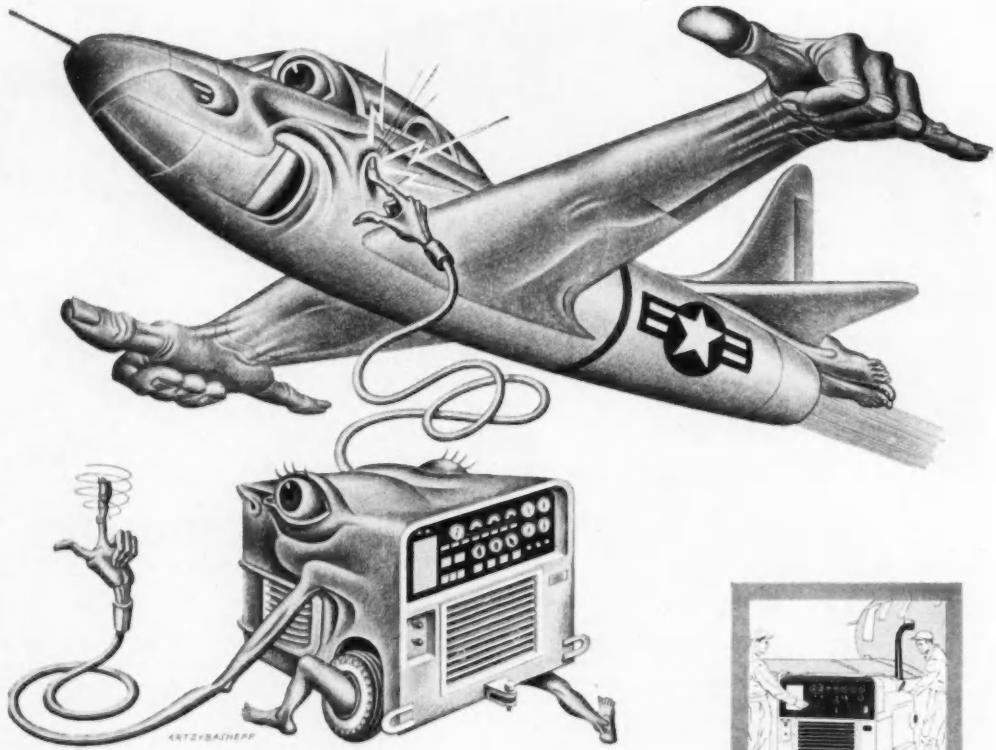


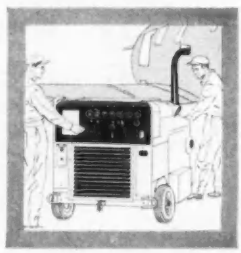
Braking with Treadle-Vac is not only easier, but it is faster as well. Shifts from "go" to "stop" control are made in one fourth less time. This can mean five feet shorter stopping distance at 60 miles per hour.

–A Low, Light-pressure Brake pedal

Comparable to the

Accelerator in Operating Ease!





Hot "juice" for cold jets

One generator for any climate, many uses! *Air-cooled*—to withstand −65° or +135°F. *Portable*—to wheel along rows of waiting jets. *Light* and *compact*—to tuck in a B-36 for dependable starting anywhere in the world. That's the power package developed by Lycoming and the United States Air Force.

If your need is power—or precision-machining, product development or high-volume production—Lycoming offers unusually extensive facilities and well-rounded experience. Long famous for aircraft engines, particularly to the military, Lycoming also meets the most exacting requirements of America's leading industries.

Whatever your problem, look to Lycoming!

AIR-COOLED ENGINES FOR AIRCRAFT AND INDUSTRIAL USES, PRECISION-AND-VOLUME-MACHINE PARTS, STEEL-PLATE FABRICATION, GRAY-IRON CASTINGS

When the United States Air Force needed a sure-fire power package to start jets blasting in any weather, **they called on Lycoming for research and precision production.**

LOOK TO **LYCOMING** FOR RESEARCH FOR PRECISION PRODUCTION

LYCOMING-SPENCER DIVISION, WILLIAMSPORT, PA.
BRIDGEPORT-LYCOMING DIVISION, STRATFORD, CONN.

AVCO MANUFACTURING CORPORATION

Aeroquip

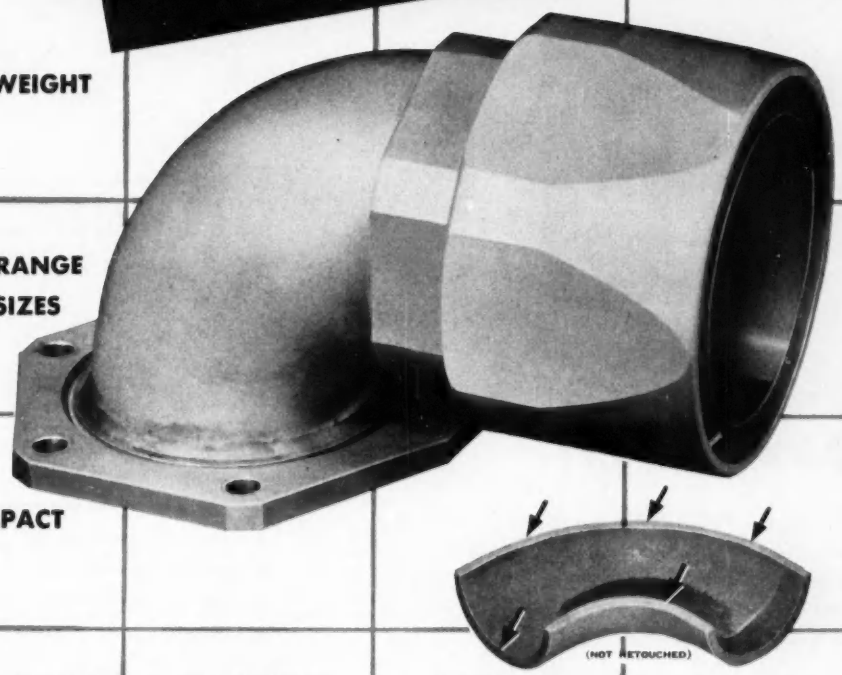
REG. TRADE MARK.

ALUMINUM ELBOWS

LIGHTWEIGHT

FULL RANGE OF SIZES

COMPACT



AN SWIVEL NUT AND FLANGE TYPES

AEROQUIP QUALITY THROUGHOUT

UNIFORM WALL THICKNESS

FULL FLOW

AEROQUIP CORPORATION

JACKSON, MICHIGAN

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AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U.S.A. AND ABROAD

for versatile force measurement equipment . . .

use the

HAGAN

THRUSTORQ

and here's why:

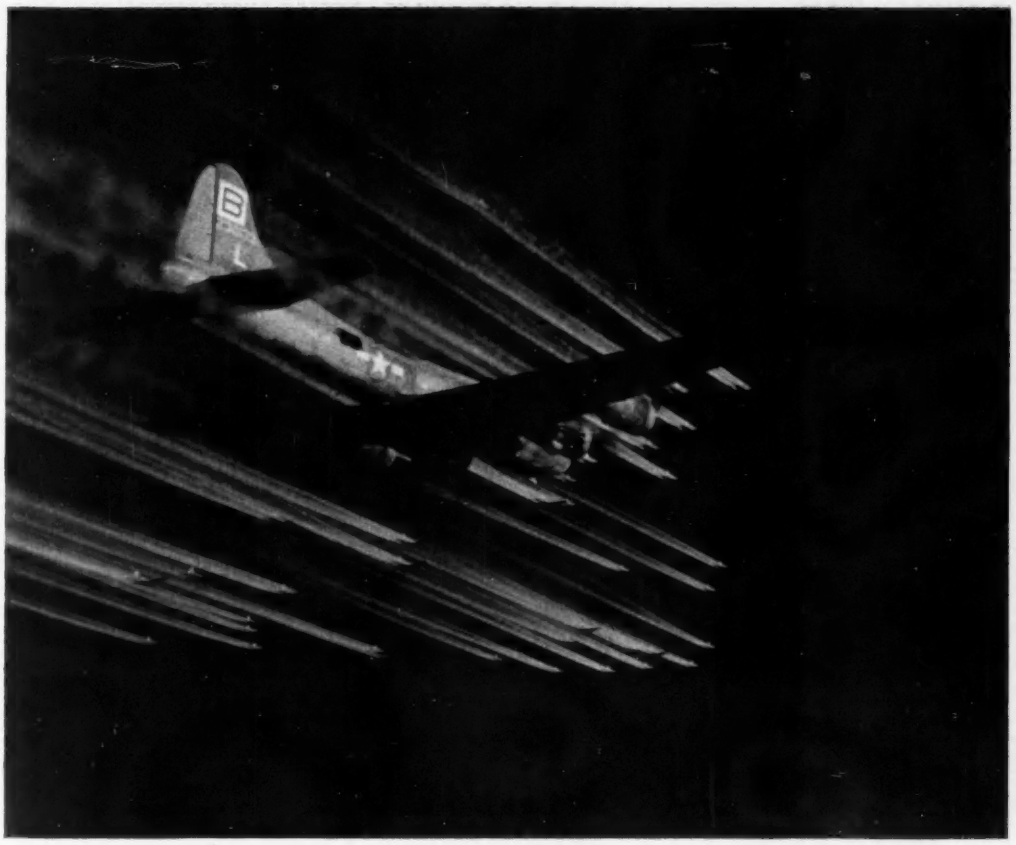
The Hagan THRUSTORQ has proved itself time and time again for force measurements. The THRUSTORQ is simple, rugged, and accurate. This partial list of applications gives an idea of THRUSTORQ possibilities:

- **cradle dynamometer measurement of airplane and automobile engines**
- **rocket thrust measurement**
- **testing piston rings**
- **torque measurement of helicopter engines**
- **jet engine thrust measurement**
- **chassis dynamometers**
- **axle testing machines**
- **portable test stands for planes**
- **automatic batch weighing**

The Hagan THRUSTORQ may be the answer to your force measurement problems. Our engineers are at your service. Write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.

HAGAN THRUSTORQ
measuring thrust and torque *with air!*

HAGAN
HALL
BUROMIN
CALGON



We hired an engineer over Berlin

"The Boeing Flying Forts came through a wall of flak and fighters that night to hit Berlin right on the nose. They never let us down—not then or on any of the raids to come. I was proud to fly the old Boeings. Now I'm prouder still to be on the great engineering team that designs the new ones."

Boeing engineers feel that way. And they'd be honored to have you join them as they pioneer in dramatic new fields of aviation. There are excellent openings in Seattle now for experienced and junior aeronautical, mechanical, electrical, electronics, civil, acoustical, weights and tooling engineers for design and research; for servo-mechanism designers and analysts; and for physicists and mathematicians with advanced degrees. Or, if you prefer the Midwest, there are similar openings at the Boeing Wichita, Kansas, Plant. Inquiries indicating a preference for Wichita assignment will be referred to the Wichita Division.

The steady growth of Boeing's Engineering Division over the past 35 years is an index of stability. There's great work to be done in all phases of aircraft design . . . in the fascinating new field of guided missiles . . . in jet propulsion.

You'll find here some of the world's best research facilities and you'll work with men who have helped establish Boeing's world leadership in aviation research, design and engineering. You'll like the pay, too. It's good and it grows with you. Moving and travel expense allowance is provided.

Be a Boeing man. No other name in aviation will loom larger in importance during the years to come.

Write today to the address below, or use the convenient coupon.

JOHN C. SANDERS, Staff Engineer—Personnel
Dept. P-2
Boeing Airplane Company, Seattle 14, Wash.

Engineering opportunities at Boeing interest me. Please send me further information.

Name _____

Address _____

City and State _____

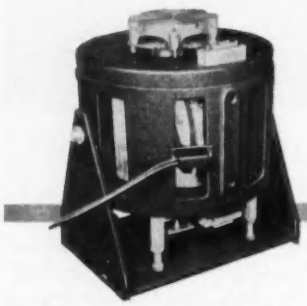
BOEING

How MB can help you

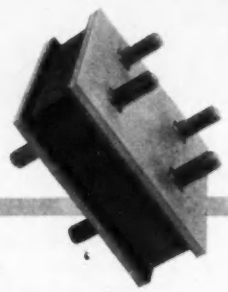
MEET MILITARY SPECIFICATIONS ON VIBRATION

DOES YOUR MILITARY PRODUCTION require vibration *testing?* Shock *absorption*—vibration *isolation?* Representative of MB's specialized vibration engineering, these products show that, from a single source, you can get the equipment and information you need to meet your requirements. For example:

1. **MEASUREMENT** of vibration with MB vibration pickup and meter supplies data for study of disturbing frequencies and for design adjustments. The electrically damped and highly sensitive pickup is convertible for horizontal or vertical operation. Meter gives you accelerations, velocities or displacements of the vibrations directly. Made for each other, the two are the "eyes" for any vibration testing program.



2. **SHAKE TESTING TO MIL-E-5272 and 41065-B** is easily accomplished with MB Vibration Exciters. Model S-3 shown delivers 200-lb force. Others available with 10-lbs to 2500-lbs force ratings—all easily, quickly and accurately controlled for force and frequency.



3. **ISOMODE* SHOCK MOUNTS** have been developed for supporting and protecting aircraft engines from damage while transported in crates or "cans." High load capacity combined with high deflection capacity provides good absorption of shock. **Reg. U.S. Pat. Off.*

4. **MIL-I-5432** (AN-I-16a) can be met with the Type 17 ISOMODE Mount. This unit available for loads from 0.5 to 100 pounds, and controls all modes of vibration with equal efficiency because of equal spring rate in all directions.

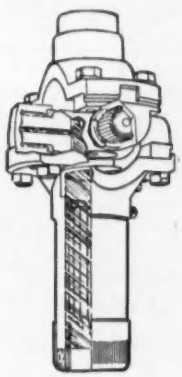
Remember, if you need help with a vibration problem, you can save yourself time and work by contacting MB's vibration specialists. For details on any of the above products, address your inquiry to Dept. N7.

THE MB MANUFACTURING COMPANY, Inc.
1060 State St., New Haven 11, Conn.

PRODUCTS FOR MEASUREMENT . . . REPRODUCTION . . . AND CONTROL OF VIBRATION

if LUBRICATION is your problem

MECHANICS joints are designed to permit generous, long-lasting lubrication — without disassembling. One "shot", through a convenient oil plug hole in the cross, fills the reservoir from which the lubricant is forced to all four bearings, equally. Another "shot" fills the slip-yoke chamber. Thoroughly efficient seals prevent leakage and keep out dirt and moisture.



MECHANICS *Roller Bearing* UNIVERSAL JOINTS BW

For Cars, Trucks, Tractors, Farm Implements, Road Machinery, Industrial Equipment, Aircraft

Let our engineers show you how this friction-reducing feature, and several other MECHANICS advantages, will benefit your new and improved models.

MECHANICS UNIVERSAL JOINT DIVISION

Borg-Warner

2022 Harrison Ave., Rockford, Ill.

Milsco
MILWAUKEE

★★★★ Commander ★★★

HEAVY DUTY CUSHION SEAT

WITH FORE AND AFT ADJUSTMENT

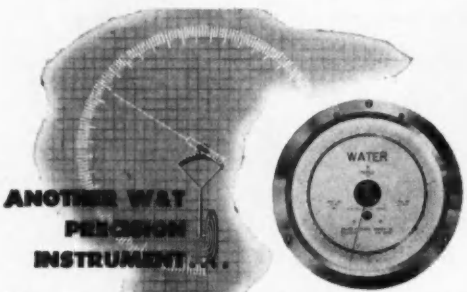
Popular for most types of mobile equipment. Quickly adjustable forward or backward with a flick of the adjusting lock-handle. Full-comfort roomy cushion seat and restful padded back. "No-Sag" synchronized action springs. Foam rubber or sisal and cotton. Artificial or genuine black cowhide.

many other styles

Simple Adjustment Fore and Aft

MILSCO MANUFACTURING COMPANY

2758 N. 33rd STREET — Famous in Seating — MILWAUKEE 45, WIS.



ANOTHER W&T PRECISION INSTRUMENT...

The W & T Precision Dial Manometer

The W&T Precision Dial Manometer answers the problem of conveniently measuring pressure with a sensitivity of 1 part in 10,000.

This sturdy, compact instrument, which is widely used for wind tunnel work, power plant test stands and in gas turbine testing, has a large easy-to-read dial. It is custom calibrated in any pressure units over various ranges up to a maximum of 200 inches of mercury.

In addition, the W&T Precision Dial Manometer possesses these outstanding advantages:

Accuracy .....1 part in 1000
Scale length ..45"
Case .....pressure tight, metal for flush mounting.
Full protection against over pressure.
Measures gauge pressure, vacuum and differential pressure.

This instrument with its sensitive response and precision results is typical of a wide variety of pressure instruments of all types — from low pressure indicators to altimeters — manufactured by W&T. If you have a problem in pressure measurement, write, telling us the details. We'll be glad to help.

WALLACE & TIERNAN
PRODUCTS, INC.
ELECTRICAL MECHANISMS AND PRECISION INSTRUMENTS
Belleville 9, New Jersey • Represented in Principal Cities

Q will ALUMINUM take MECHANICAL FINISHES?

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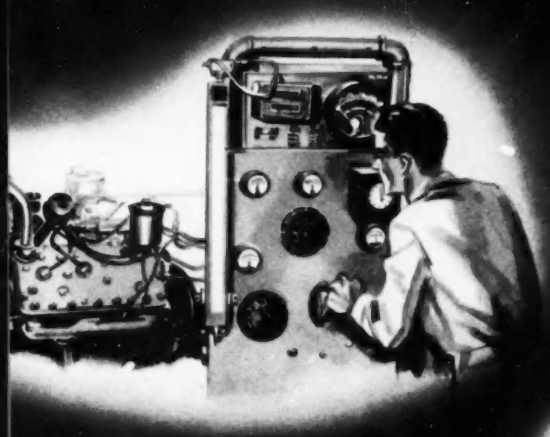
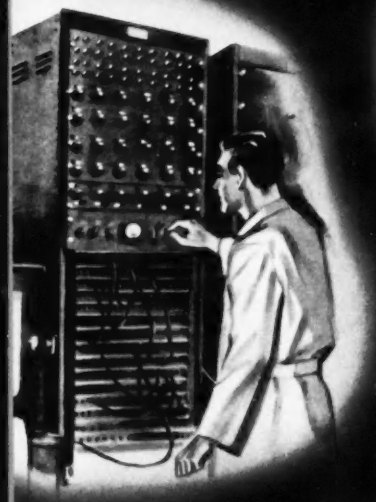


HOLLEY Presents Two New Concepts of Carburetion

Visi-flo

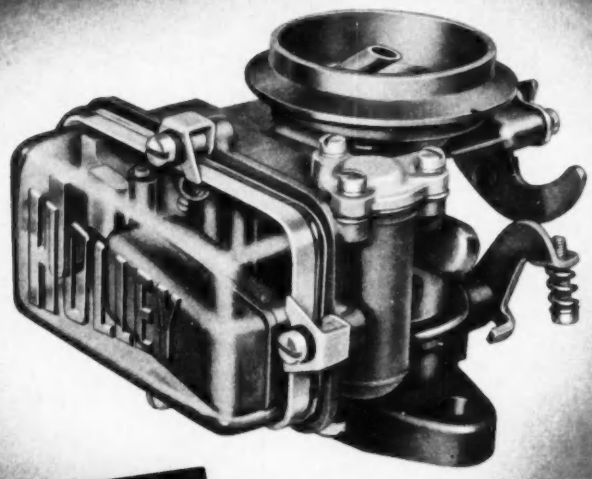
With glass fuel bowl for light cars and trucks



CENTRI-FLO

The true concentric carburetor for fine cars and heavy-duty trucks

HOLLEY Carburetor Co.



DESTINED TO REVOLUTIONIZE THE SERVICING OF CARBURETORS

HOLLEY *Visi-flo*

Fuel bowl is clear glass. The serviceman checks at a glance

- ✔ Fuel level
- ✔ Presence of sediment or water in gasoline
- ✔ Flooding
- ✔ Action of the float

Conforming to modern hood design: Overall height of the Holley Visi-Flo is only 4 inches.

HOLLEY Carburetor Co.

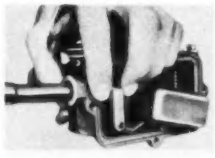
WATCH FOR THE FEBRUARY 23rd ISSUE OF

The Saturday Evening POST

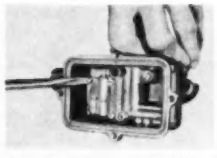
SERVICING THE HOLLEY VISI-FLO REQUIRES JUST 4 SIMPLE STEPS

All important metering parts are contained in an easily replaceable, *single assembly*. Fuel level and condition of float can be examined without removing bowl. If service is necessary, follow these simple steps:

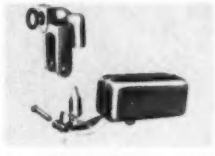
Step 1—Remove glass bowl (four screws).



Step 2—Remove complete float unit (one screw).



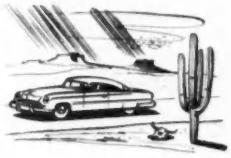
Step 3—Remove complete metering unit (five screws).



Step 4—Replace worn parts and reassemble.

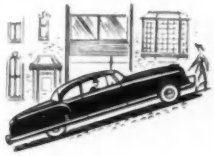
THE TRUE
CONCENTRIC CARBURETOR
WITH FULLY INSULATED
FUEL BOWL

HOLLEY CENTRI·FLO



NO PERCOLATION

Because the fuel bowl is fully insulated, there is no possibility of percolation or vapor-lock.



INSTANT STARTS ON HILLS

True concentric design assures the proper gasoline level for instant starts, even on the steepest grades.

NO MISSING ON TURNS

Again because of Centri•Flo's true concentric design, the engine will not miss on sharp turns, and will not stall during fast stops or starts.

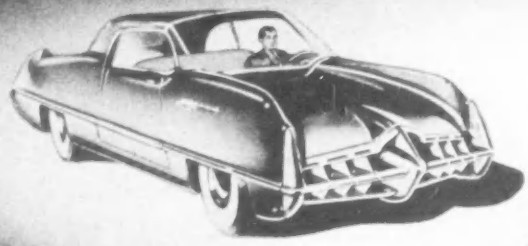
This Centri•Flo model is ideal for V-type engines with overhead valves where there is a serious installation problem with conventional carburetors. This combined carburetor-air cleaner construction insures minimum overall height.

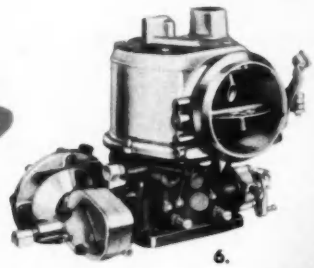
On commercial installations which require the air cleaner to be mounted away from the carburetor—an adapter-mounting is available. It rotates a full 360 degrees so that a tube may be run *at any angle from* the carburetor to the air cleaner.

HOLLEY Carburetor Co.

WATCH FOR THE
FEBRUARY 23rd
ISSUE OF

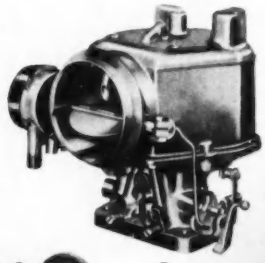
The Saturday Evening POST





6.

HOLLEY
First Name
In Carburetion
Since 1899



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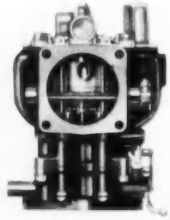

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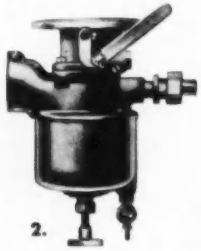

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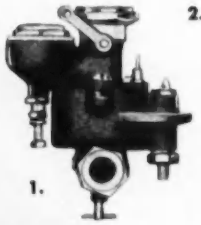

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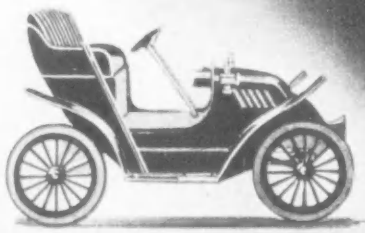

Look at the record of these Holley firsts:

1. The updraft carburetor.
2. The first metal float type carburetor.
3. The concentric carburetor for military vehicles that operates at full efficiency on extreme angles.
4. A fully vacuum controlled pressure distributor for today's modern cars and trucks.
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ORIGINAL EQUIPMENT MANUFACTURERS
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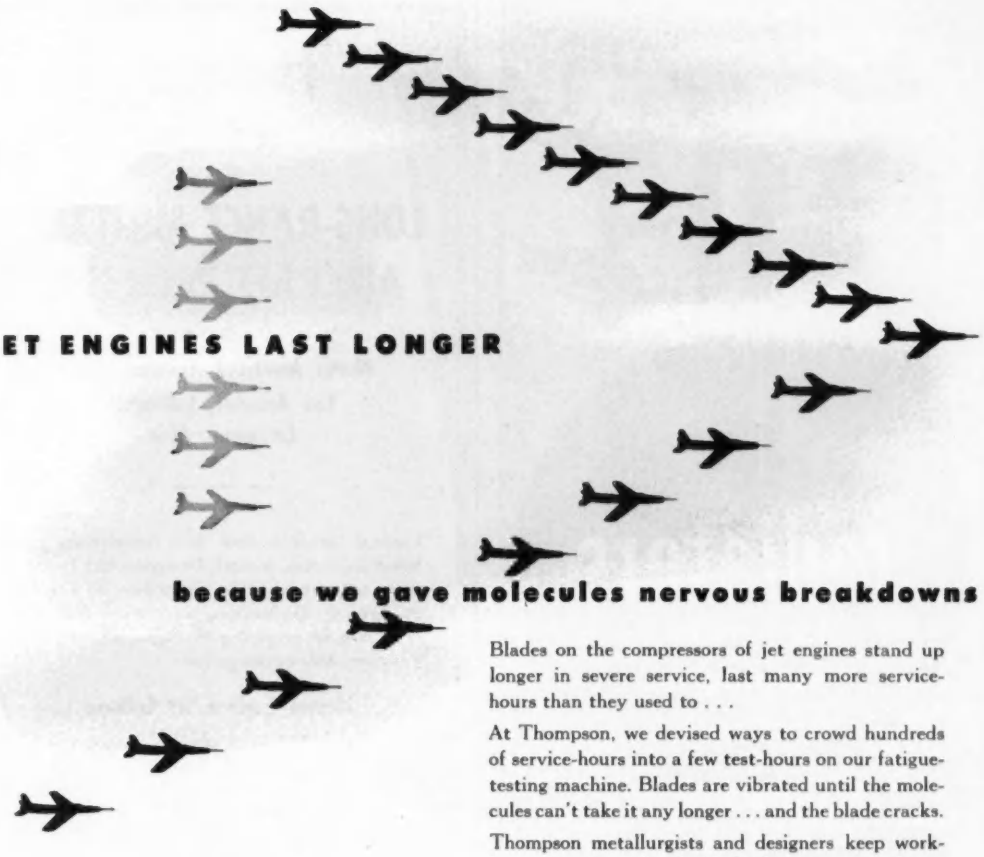


JET ENGINES LAST LONGER

because we gave molecules nervous breakdowns

Blades on the compressors of jet engines stand up longer in severe service, last many more service-hours than they used to . . .

At Thompson, we devised ways to crowd hundreds of service-hours into a few test-hours on our fatigue-testing machine. Blades are vibrated until the molecules can't take it any longer . . . and the blade cracks.

Thompson metallurgists and designers keep working at ways to make the blades last a few more hours on this testing machine . . . knowing that a few extra hours there means a few hundred extra hours for the jet compressor in the air.

What we know, and are learning, about metals and the design of parts can probably be valuable to *you*. We'd like to discuss your problems and our knowledge and facilities.

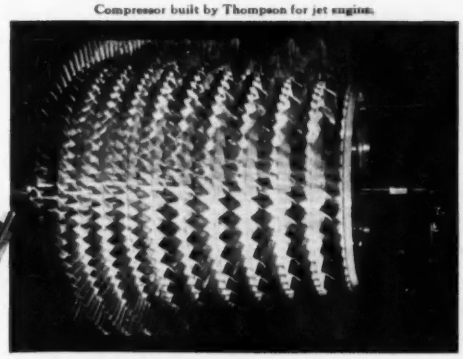
JET DIVISION

Thompson Products, Inc.

Euclid, Ohio; Harrisburg and Danville, Penna.

YOU CAN COUNT ON THOMPSON FOR ENGINEERING LEADERSHIP

Compressor built by Thompson for jet engine.



Thompson-made blade for jet-engine compressor.

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Engineering Personnel Office
Section 5

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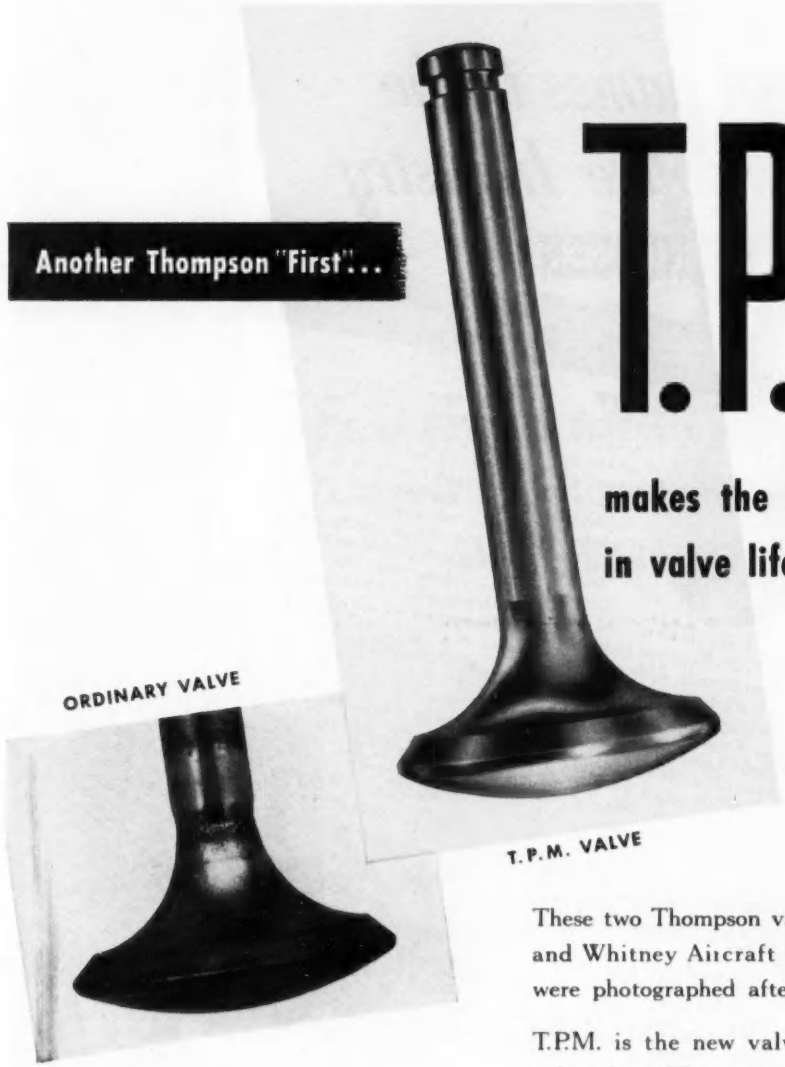
LOS ANGELES INTERNATIONAL AIRPORT
LOS ANGELES 45, CALIF.
or
COLUMBUS 16, OHIO

Another Thompson "First"...

T.P.M.

makes the big difference in valve life



These two Thompson valves from Pratt and Whitney Aircraft R-4360 Engines were photographed after first overhaul.

T.P.M. is the new valve material developed by Thompson to give greater corrosion resistance and higher strength at valve operating temperatures. T.P.M. is a result of Thompson's vast experience in valve development and knowledge of the behavior of metals at high temperatures.

Other Thompson "firsts" include a new coating alloy for valve heads and faces, and stem-peening to provide harder, more wear-resistant stem surfaces.

VALVE DIVISION
Thompson Products, Inc.
EUCLID, OHIO

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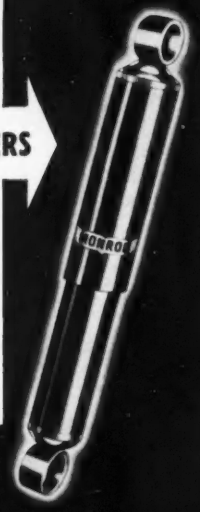
Great names in the Automotive Industry

WILLIAM S. KNUDSEN

William S. Knudsen was born in Copenhagen in 1879, and came to America at the age of 20. His association with the automobile industry began in 1911, when Henry Ford purchased the John R. Keim Mills by whom Knudsen was then employed. In his first two years with Ford, he set up 14 assembly plants and during World War I was in charge of shipbuilding at Ford's River Rouge shipyards. After the war, he was Ford production head until in 1921, when he left the company. In 1922, Knudsen joined General Motors in an advisory capacity and shortly after became president of Chevrolet, in charge of manufacturing operations. He boosted production and sales to the point where the Chevrolet became America's fastest selling car. In 1924, Knudsen was made president and general manager of Chevrolet and 13 years later he became president of General Motors Corporation. When the defense program lagged in 1940, Knudsen was called upon by President Roosevelt to direct industrial production of war materiel. He retired from military service in 1945, with the rank of Lieutenant General, and died on April 27, 1948.

(One in a series of sketches about great automotive industry pioneers.)

MONROE — THE GREAT NAME IN SHOCK ABSORBERS



Together with better highways, improved ride control devices have greatly smoothed travel for America's autos, trucks and buses during the last half century. Monroe has pioneered in developing the best ride control products —shock absorbers, sway bars, struts and molded rubber parts. Today, Monroe ride control products are top choice among America's automotive engineers.

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Monroe Shock Absorbers are standard equipment on more makes of new cars than any other brand of shock absorber.

MONROE AUTO EQUIPMENT CO.

Monroe, Mich. — World's Largest Maker Of Ride Control Products

Help a jet go further..faster ..with the new Thompson AIR-TURBINE PUMP

Typical afterburner pump model weighs only 9.0 lbs., but delivers 35 H.P.

Air-turbine operates at speeds up to 30,000 R.P.M. with 500° F. air. The pump will operate over −65° F. to +250° F. temperature range. Can be used with all military fuels.

Again, Thompson leadership brings you a Thompson "First" . . . the first fully-proved, service-tested air-turbine pump.

New, and proved in the air, the Thompson air-turbine pump uses air from the jet compressor to pump fuel to the afterburners for additional jet thrust. It can produce a pumping effort equivalent to 35 H.P., yet weighs only 9.0 lbs.

Designers like the flexibility of placement and installation that the Thompson air-turbine pump provides.

May we tell you more about this newest Thompson development and other developments of air-turbine accessories?

ACCESSORIES DIVISION

Thompson Products, Inc.

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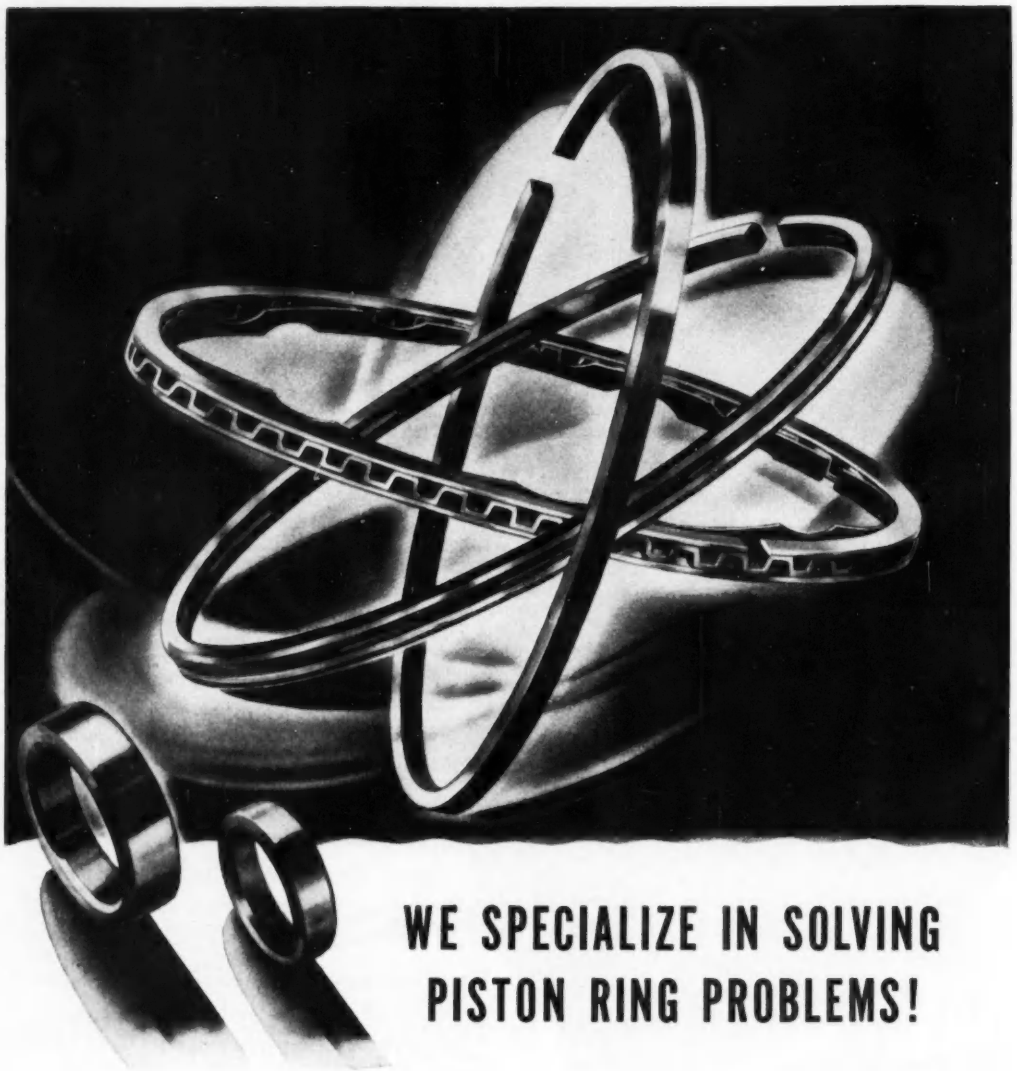

WE SPECIALIZE IN SOLVING PISTON RING PROBLEMS!

If you need help on the design or production of piston rings, Wausau is exceptionally well qualified to work with you. For Wausau has *specialized* on piston rings for over twenty-five years, supplying them both for original equipment and for service use. Wausau has kept pace with every advance in engine design, responding with many outstanding innovations in engineering and manufacture. Most significant fact of all is that Wausau today numbers among its customers over sixty leading builders of gasoline and Diesel engines.

With valve seat inserts, too, Wausau offers important advantages as a supplier. Wausau has, for instance, developed inserts for virtually every type of application, including specially alloyed cast iron, steel, bronze, and bi-metal corrosion-resistant types.

Wausau invites you to make full use of its long experience and its complete facilities. *Wausau Motor Parts Company, Wausau, Wisconsin.*

WAUSAU

THEIR ACCEPTANCE PROVES THEIR WORTH

DUREX-100 ENGINE BEARINGS

Leading makers of cars and trucks have accepted Durex-100 as original equipment. This acceptance proves far better than claims the dramatic superiority of these advance-type engine bearings. The *difference* between the Durex-100 and conventional bearings is their greater endurance and longer life.

In making Durex-100 bearings, the steel back is covered with a layer of metal powders that are sintered to form a porous matrix firmly brazed to the steel back. A high-lead babbitt is then mechanically and metallurgically bonded to the matrix.

This exclusive Durex-100 matrix makes the difference. This matrix provides greater embedability — actually absorbs abrasive particles; protects the bearing and the crankshaft from possible serious damage.

We'd like to tell you a fuller story of Durex-100 bearings and how they can be used to advantage in your engines.

MORAINE PRODUCTS
DIVISION OF
GENERAL MOTORS
DAYTON, OHIO

ALCOA -your first source for ALUMINUM CASTINGS

- Four modern foundries, two die casting plants—strategically located from coast to coast.
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- 41 years in the casting business, 30 years in the die casting business, 64 years of aluminum experience.
- Design and development help backed by the world's greatest aluminum research facilities.

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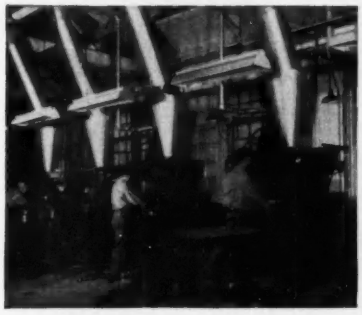
Facilities like these mean satisfaction with your source of supply—

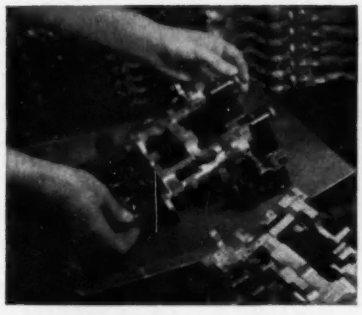


CORE MAKING—fast, high quality production of cores is assured by Alcoa's modern sand handling equipment and large capacity core ovens.

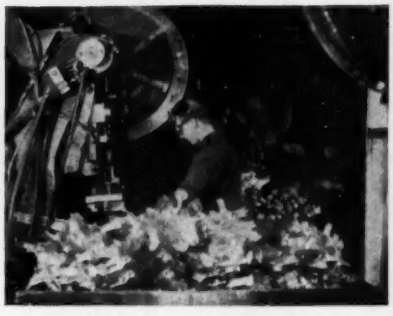
POURING TEMPERATURES—are constantly checked and recorded at control stations on all foundry floors. Procedure like this and continuous alloy control guarantee highest quality aluminum castings and die castings.

HIGH PRODUCTION CAPACITY—of Alcoa's die casting plants is partially represented in this row of cold chamber machines at Alcoa's Chicago die casting plant.

PERMANENT MOLD CASTING—formerly considered for small parts only. Today permanent mold castings weighing up to 500 pounds are not unusual.



INSPECTION—of every part is standard practice in Alcoa plants. Dimensional checks, as shown here, or visual inspection by trained personnel reduces costly rejects. Metallurgical checks further guard the castings' quality.



FINISHING—many secondary machining operations are performed by Alcoa foundries and die casting plants. Machining, grinding, sand blasting, and ball burnishing are but a few.

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While the sale of our products is presently controlled by government regulations, you'll find no limitations on help in design, application or fabrication. Your local Alcoa sales engineer and your local Alcoa distributor are headquarters for "everything" in aluminum. They will cooperate to the fullest in helping you get the metal you need. They are listed under "aluminum" in your classified phone book.

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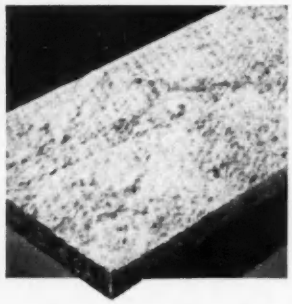
Insulates motor cars against heat, cold, noise for greatest passenger comfort. Lightweight; low moisture absorption; won't deteriorate under normal conditions, easily installed.



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LIBBEY-OWENS-FORD has been known for years as a supplier of fine automotive glass, a source familiar with the industry's rigid production and scheduling requirements. Now, L-O-F offers an excellent product for automobile insulation, L-O-F Fiber-Glass.

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How thin can a head gasket be, yet assure effective sealing of modern high compression engines?

Studebaker engineers found the answer in VIC-2-FOLD—the thinnest practical metal-asbestos construction, yet having adequate compressibility for positive sealing. On the engine, VIC-2-FOLD, as shown, compresses to 3/64" while providing maximum breakdown and corrosion resistance. Studebaker's *Commander* and *Land Cruiser* models use VIC-2-FOLD head gaskets exclusively.

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Wherever automotive design calls for sealing with gaskets, shaft seals, or packing, Victor is at your service. For all such applications, Victor offers the industry's foremost facilities for developing and manufacturing sealing products that assure better service and greater satisfaction.

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Compressible to 3/64" average on engine, VIC-2-FOLD is the thinnest practical encased asbestos gasket construction, utilizing the high strength of steel and the corrosion-resistance of copper. Note how steel bottom layer is formed up in combustion chamber openings, overlapping copper top layer for maximum protection against breakdowns and blowouts. Inversely, in coolant openings, copper layer is formed down to overlap steel layer, for maximum corrosion-resistance in contact with coolants and anti-freeze solutions.

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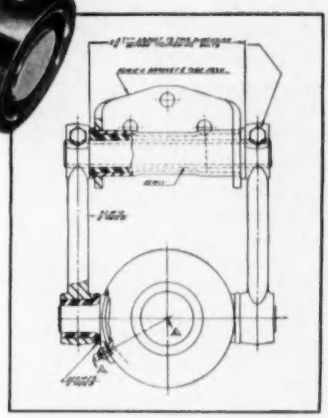

A midshaft bearing hanger for trucks that permits standardizing on propeller shaft lengths.

THOMPSON engineering has perfected a center bearing hanger assembly that assures exceptional ease of service. The unit is completely symmetrical. Its flexibility eliminates the need for precise positioning by shims. Adjustments are eliminated because the bearing is retained by two simple snap rings.

Standard annular ball bearing has longer life and greater capacity than self-aligning type. Free swinging, the swing arms and rubber bushings eliminate cramping and thrust loading of the bearing due to frame twist and drive line movement. A combination of shaft seals and slingers provides ideal bearing operating conditions.

High frequency vibration is reduced by the use of 4 small rubber bushings widely spaced and acting in tandem instead of the conventional large mass of rubber that permits major displacement resulting in shaft shimmy. The hanger insulates the vehicle drive line from the frame, reducing the tendency to transmit noise to the vehicle cab.

Investigate this Thompson development. Let us tell you how it will cut production and distribution costs. If you have steering or chassis problems, let Thompson engineers help you solve them. Thompson Products, Inc., 7881 Conant Avenue, Detroit, Michigan. Phone: WA 1-5010

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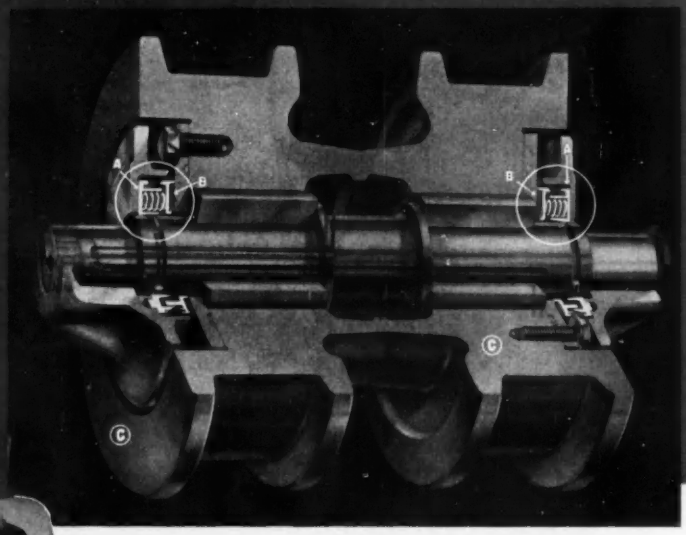

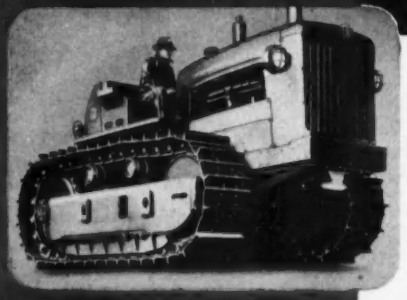

FROM KODIAK TO KARACHI IH CRAWLERS MUST ROLL WITH RELENTLESS DEPENDABILITY

PROBLEM: As International Harvester Crawlers roll through Arctic mud or burning sand, trackroller bearings must be continuously and effectively protected. The rollers which bear the full weight of the tractor rotate on stationary shafts mounted in a frame. These rollers, bearings and shafts are subject to great strain from various directions as the tractor rolls over uneven terrain.

Any intrusion of mud, dirt, water or sand would cause wear on the bearings and shafts. Efficient operation of the trackrollers requires the exclusion of all foreign material and retention of lubricant.

SOLUTION: C/R "Perfect" oil seal, (A), Type "VD" end face seal, mounted in a stationary housing which forms a cover for the shaft end. (B) The specially treated leather face of the seal operates in contact with a flat steel mating plate which rotates with the roller (C). These contact surfaces perform the sealing operation which excludes mud, dirt, water, sand and all road materials and retains bearing grease, a performance necessary for the relentless all-weather dependability of International Crawlers.

Solving tough or unusual sealing problems is C/R's specialty. That's why more automobiles, more agricultural and industrial machines are relying on C/R than any other sealing device.

The cooperative research and engineering services which C/R has provided to produce special C/R oil seals (both synthetic rubber and leather) for leading manufacturers are available to you. We will be pleased to send you any information you wish. Brochure on request.

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1309 Elston Avenue OIL SEAL DIVISION Chicago 22, Illinois

P.S. For immediate delivery, C/R "Perfect" oil seals are stocked in over 1800 sizes covering 15 different types.

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Mechanical Leather Products
Boots, diaphragms, packings and other products give dependable service under difficult operating conditions.

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The Scientifically Compounded Elastomer
Custom-engineered and custom-built for critical service in aircraft, automotive and other mechanisms.

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Manufactured and distributed in Canada by Super Oil Seal Mfg. Co., Ltd., Hamilton, Ont.

Tandem bearings made

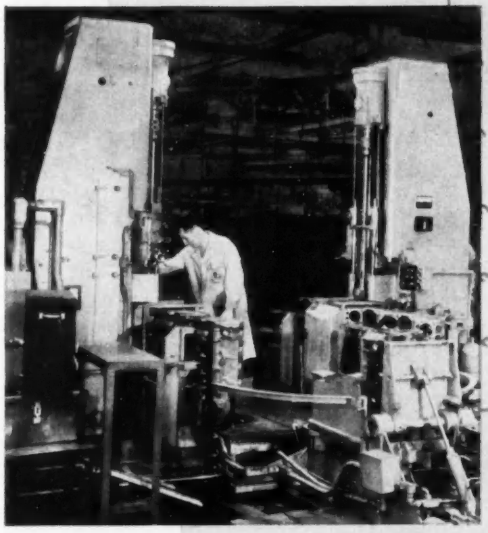
ROUND ★ STRAIGHT ★ IN LINE

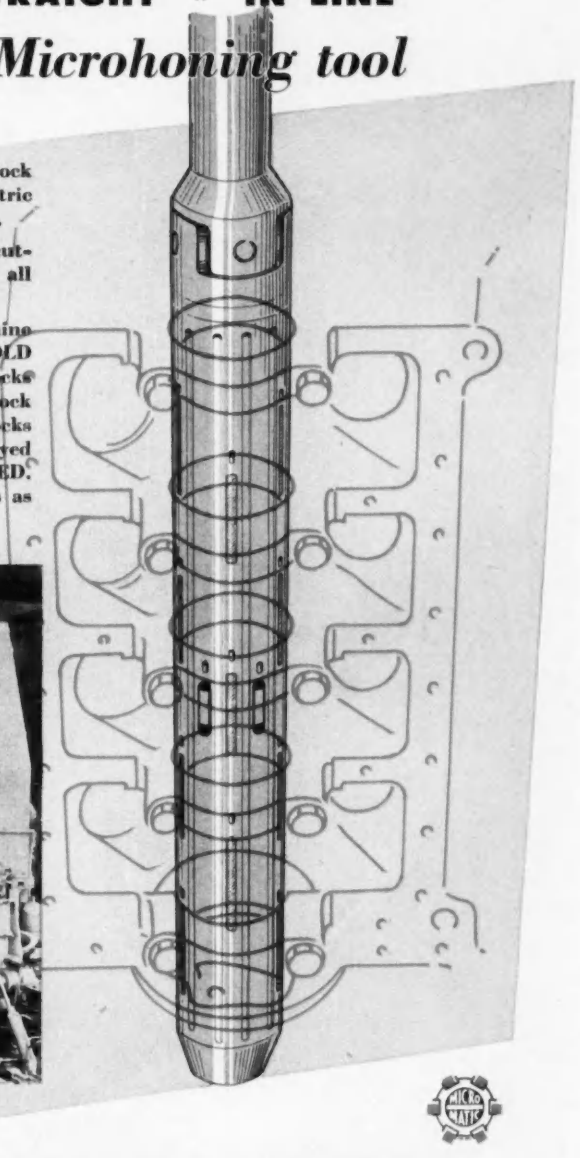
with NEW *Microhoning tool*

ALL FIVE bearings in V-8 cylinder block MICROHONED within .0005" for diametric size, roundness, straightness and alignment.

Plastic guides stabilize tool and control cutting. One bank of abrasives MICROHONE all bores.

This double column Model 740 machine equipped with new guided type MICROMOLD tools MICROHONES Main Bearings in 60 blocks per hour, removing approximately .002" stock from the diameter of each bearing. The blocks are automatically taken from the line, conveyed to either of the columns, and MICROHONED. The operator makes occasional spot checks as the blocks leave the machine.





Write for Cross Hatch for complete story on MICROHONING Interrupted Surfaces.

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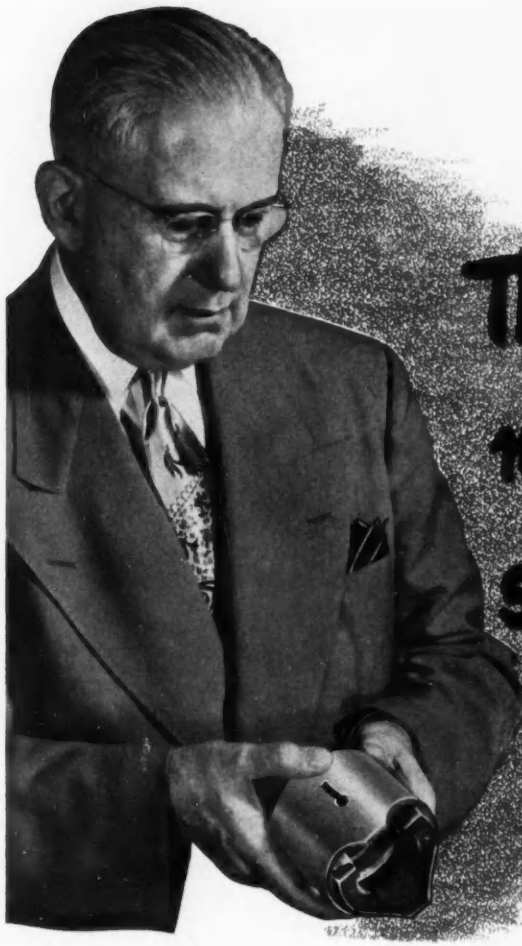
ANOTHER THOMPSON DEVELOPMENT

Three ring controlled aluminum pistons for high compression engines with scalloped skirt.



Thompson packs more power into smaller packages

NEW opportunities for cutting costs of intricate parts are being opened up by Thompson Products' advanced developments in casting light metals in permanent mold and high pressure dies. In many fields, ferrous castings are being replaced by more efficient light alloys of aluminum and magnesium. Records show resulting benefits to industry to stronger, more durable products requiring considerably less machining and finishing, and better heat conductivity. Through Thompson's unique developments in quality control and moulding methods, dependable uniformity from piece to piece is eliminating costly scrap losses.

Thompson's creative engineers will gladly put their many years of experience to work for you by showing where and how you, too, can simplify your operations with light metals and save on costs. Simply write Thompson Products, Inc., Light Metals Division, 2269 Ashland Road, Cleveland 3, Ohio.

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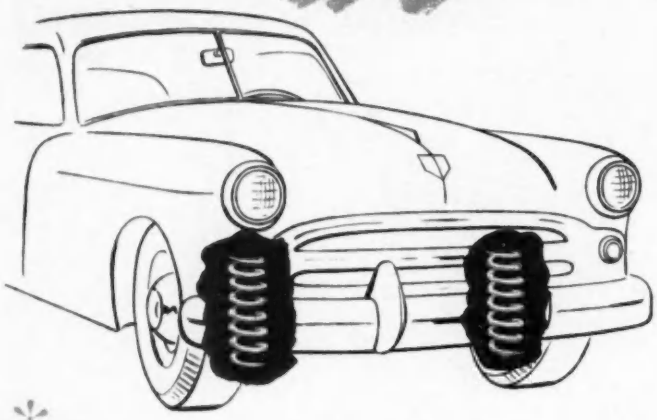
Other Examples of How Thompson Light Metals Serve Industry: **End Frames for Fractional Horsepower Motors •Housings for Garbage Disposal Units •Fan Blades for Industrial Ventilators •Fluid Drives for Automotive Transmissions •Bazookas for Army Ordinance**

Think of

Standard* Steel Spring Company

MAIN OFFICE: CORAOPOLIS, PA.



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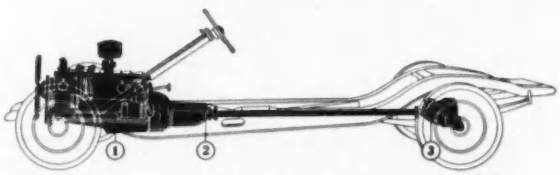
The Power You Want—When You Want It

Where You Want It . . .

that's Pontiac's New *Dual-Range* Performance



① More Powerful High-Compression Engine

② Wonderful Dual-Range Hydra-Matic Drive*

③ New High-Performance Economy Axle

Be sure to see the great 1952 Pontiac! It brings you General Motors' sensational new Dual-Range Hydra-Matic Drive*—coupled with Pontiac's great high-compression engine—and a new high-performance, economy axle. At the *touch of your finger*, you can elect to have tremendous acceleration and snap and go! Or, with equal ease, you can choose an altogether *different* type of performance; silken, gliding, gas-saving—perfection itself for the open road. In other words, you have the power you want —*where* and *when* you want it. And there are many *other* advancements in the new Pontiac, too. Better *see* it—*drive* it—today.

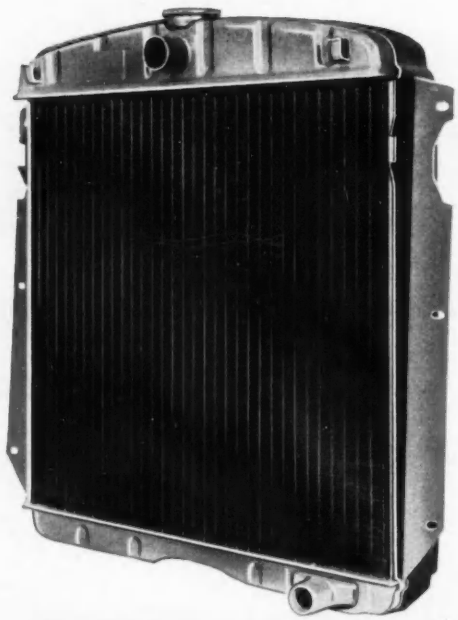
*Optional at extra cost.

DOLLAR FOR DOLLAR YOU CAN'T BEAT A PONTIAC · PONTIAC MOTOR DIVISION OF GENERAL MOTORS CORPORATION

cooling problems?

bring them to...

HARRISON



When Harrison engineers tackle a particular cooling problem, they take into consideration *all* the factors affecting cooling.

Heat rejection, air flow, and coolant circulation are thoroughly investigated, and the results are carefully analyzed before the radiator is selected.

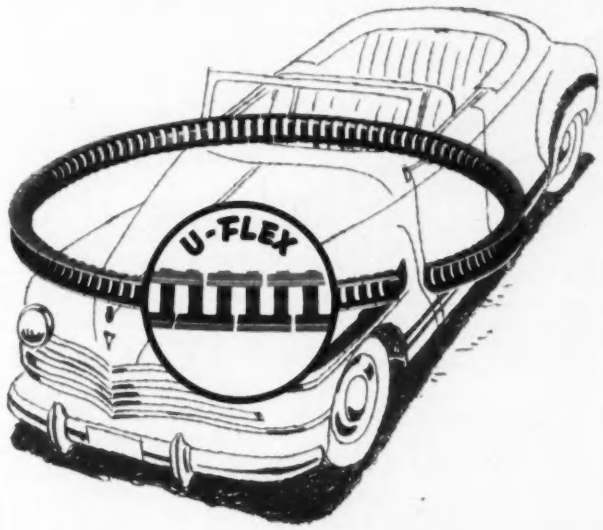
Finally, the entire cooling system is subjected to tests that simulate the severest operating conditions that may be encountered.

The result is a radiator engineered to do a specific job and do it well.

Our engineering and manufacturing facilities are at your disposal. We invite you to make use of them.

HARRISON

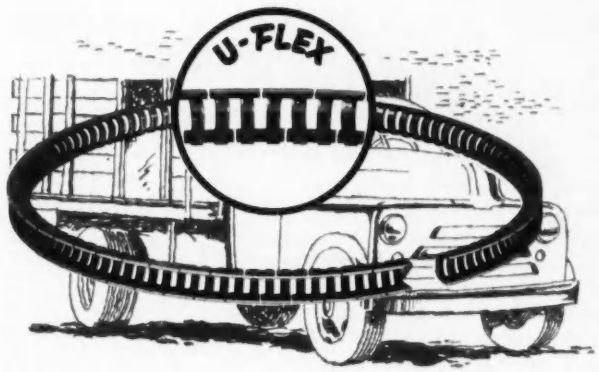
HARRISON RADIATOR DIVISION, GENERAL MOTORS CORPORATION, LOCKPORT, NEW YORK



A PISTON RING to satisfy any oil control problem . . . that's Thompson's U-FLEX OIL CONTROL PISTON RING—used as original equipment by many car and truck manufacturers. Look at it closely. You'll find:

1. SIMPLE DESIGN that permits mass production yet gives premium performance at cost of ordinary rings.
2. EXTREME FLEXIBILITY permits conformity to cylinder walls—round, out-of-round, tapered or worn.
3. ONE-PIECE CONSTRUCTION assures low assembly cost. No shims or expanders required. Oil drain holes are never covered.
4. WIDE OPEN CHANNEL with no obstructions where carbon builds assures maximum oil drainage, long life without clogging.

For engine performance you can take for granted: *count on* Thompson



5. LIGHT WEIGHT allows U-FLEX to follow tapered or out-of-round bores closely at high speed.
6. MULTIPLE GAPS distribute oil uniformly around cylinder wall reducing scuffing in upper ring area.
7. ANY DEGREE OF UNIT WALL PRESSURE, to meet the oil control problem at hand, is possible with U-FLEX spring-type construction.
8. RING GROOVE DEPTH variations do not affect U-FLEX wall pressure.

The Thompson engine test laboratories and staff of well-trained engineers are available to engine builders in solving internal combustion engine problems. Call us on any oil control problem.

Thompson Products, Inc.

SPECIAL PRODUCTS DIVISION

2196 Clarkwood Rd. • Cleveland 3, Ohio

PISTON PINS • VALVE SEAT INSERTS • CYLINDER SLEEVES • WATER PUMPS • U-FLEX PISTON RINGS • CAST IRON PISTONS • VALVE RETAINER CAPS AND LOCKS

Heating elements embedded in Silastic are used to prevent icing of air intake doors on jet engines.
In diesel-electric locomotives, Silastic gaskets for cylinder liners, water ports and oil pans, eliminate major overhauls previously caused by premature failure of organic rubber seals.
In spite of hot oil and long exposure to temperatures ranging from below zero to 400-450° F., Silastic spark plug boots exclude moisture; make automobile engines easy to start on wet mornings.

Silastic* works where ordinary rubber fails

At temperatures from −100° to over 500° F.,
in contact with hot oil at 350-400° F.,
in spite of weather, corona, shock and vibration,
you can count on Silastic to maintain a tight seal
or to confine electricity at high or low voltages.
That's proved by the fact that Silastic is used
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and rocker box covers on aircraft;
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in the measurement of average speed of rotation

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Chrono-Tachometer

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Wherever precise measurement of speed of rotation is required.

Ruggedly built for continuous service, in portable cases or ready for panel mounting . . . We also design and build speed measuring instruments for many special purposes.

Your inquiry is invited

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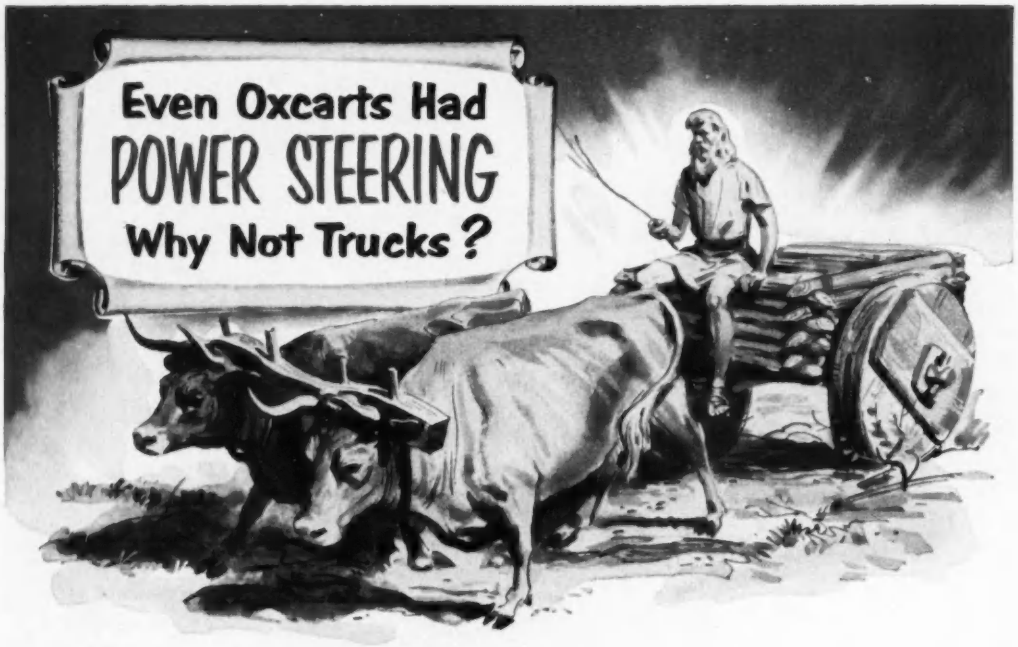

When the earliest oxcart creaked and groaned its way in man's most ancient effort at wheel transportation, the driver who shouted the primitive equivalent of "gee" and "haw" had the benefit of power steering. For, he only guided the oxen with his voice or whip—the animals supplied the power for turning.

These days about all we see of the ox is the hamburg in the corner joint, but in taking the animal out of transportation we have loaded part of its work on the drivers of trucks and other vehicles. In trucks without power steering, the driver's muscles have to supply the turning effort. The power must come from his arms, shoulders and back.

Is it progress when we build vehicles that require more physical effort to steer than oxcarts? No wonder drivers tire and become less efficient—lose the fresh alertness that assures safety.

Vickers Hydraulic Power Steering is much better than the ox because you don't have to yell at it or beat it. It takes the work out of steering . . . requires little more effort than a wave of the hand. Wheeling a truck around is so much less tiresome that the driver remains fresh, efficient, safe. For further information, ask for Bulletin M-5100.

VICKERS Incorporated
DIVISION OF THE SPERRY CORPORATION

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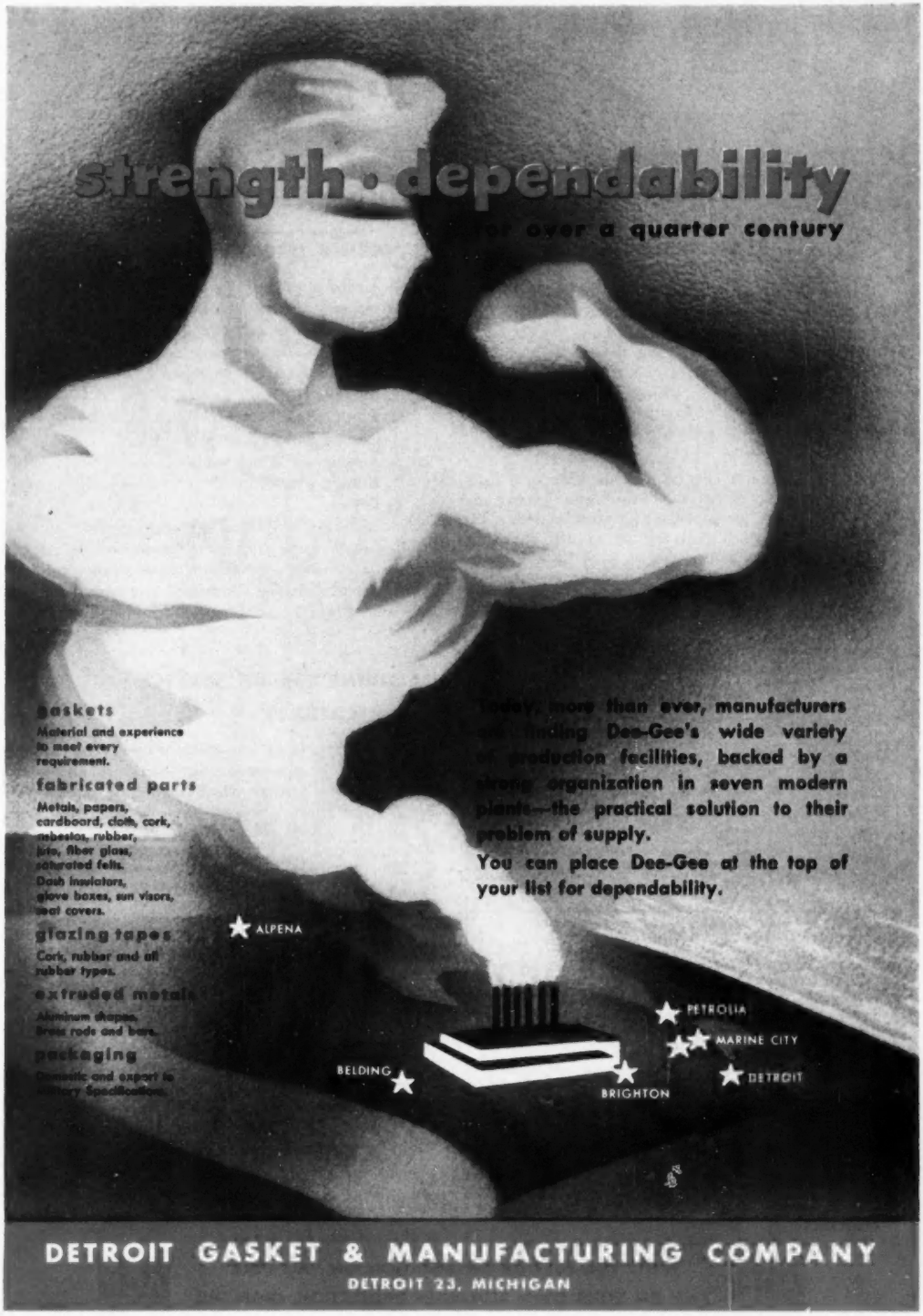
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for over a quarter century
gaskets
Material and experience to meet every requirement.
fabricated parts
Metals, papers, cardboard, cloth, cork, asbestos, rubber, jute, fiber glass, saturated felts. Dash insulators, glove boxes, sun visors, seat covers.
glazing tapes
Cork, rubber and all rubber types.
extruded metals
Aluminum shapes. Brass rods and bars.
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Domestic and export to military specifications.
Today, more than ever, manufacturers are finding Dee-Gee's wide variety of production facilities, backed by a strong organization in seven modern plants—the practical solution to their problem of supply.
You can place Dee-Gee at the top of your list for dependability.
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Technical Service Data Sheet
Subject: Protecting Aluminum with "ALODINE"®

INTRODUCTION

Aluminum not only corrodes when exposed unpainted to the atmosphere (particularly in moist, salt-laden air or industrial fumes) but also sheds paint unless the surface is actually changed prior to finishing. Simple treatments involving cleaning, or etching, or both, which heretofore have been used extensively, do not change the chemical composition of the surface and are inadequate. Far from retarding the corrosion of unpainted aluminum, such processes may in fact stimulate it.

In general, coatings integral with the aluminum itself have proved to be far more effective than cleaning and etching treatments for bonding paint and protecting the metal. "Alodine", which forms a stable, durable, non-metallic surface on aluminum, anchors the paint finish, prolongs paint life, and protects aluminum exposed unpainted in moist and salt-laden atmospheres.

CHARACTERISTICS OF THE "ALODINE" COATING	
TYPE	Non-metallic surface, integral with aluminum it protects.
COLOR	Depending on alloy treated, color range is from an iridescent blue-green to a dark slate grey.
THICKNESS	From 0.01 to 0.08 mil. No appreciable dimensional changes occur when aluminum is Alodized.
WEIGHT	50 to 300 mgs. per square foot. Optimum: 100 to 200 mgs. per square foot.
SOLUBILITY	Insoluble in water, alcohol, solvents, etc. Insoluble in most dilute acids and alkalis. However, strong acids and alkalis which attack aluminum may penetrate the "Alodine" film and react with the underlying metal. Slightly soluble in concentrated nitric acid. Soluble in molten sodium nitrate, etc.
ELECTRICAL RESISTANCE	High dielectrical resistance.
HEAT STABILITY	Unimpaired at temperatures that melt aluminum.
FLEXIBILITY	Integral with and as flexible as the aluminum itself. Can withstand moderate draws.
ABRASION RESISTANCE	Approximately 90% of that provided by chromic acid anodized aluminum.
SALT SPRAY	Painted—superior to chromic acid anodizing. Unpainted—comparable with chromic acid anodizing.
PAINT-BONDING	Excellent. Equal to or superior to anodizing.
TOXICITY	Non-toxic.
BIMETALLIC CORROSION RESISTANCE	Shows good resistance against bimetallic or galvanic corrosion.

ALODIZING IS EASY AND EFFECTIVE

The Alodizing process is a chemical one and does not require electrolytic techniques or equipment. Alodizing is simple, foolproof, low in cost, and requires a minimum of equipment. Essentially, the process consists of the following easily controlled operations or steps:

1. Cleaning the work.
2. Rinsing the cleaned aluminum surfaces.
3. Coating with "Alodine."
4. Rinsing with clean water.
5. Rinsing with warm "Deoxylyte" (acidulated rinse).
6. Drying.

After treatments. Alodized aluminum provides an ideal bonding surface for paint, wax, adhesive, or other organic finishes. These should be applied in accordance with the manufacturer's directions. Unpainted or exposed areas will be protected by the tough, durable "Alodine" surface.

"ALODINE" MEETS SERVICE SPECIFICATIONS

"Alodine" applied by immersion or spray complies with the rigid performance requirements of both industrial and Government specifications. The following is a list of Service Specifications which "Alodine" meets at the present time.

MIL-C-5541 — U. S. Navord O.S. 675
MIL-S-5002 — 16E4 (SHIPS)
AN-F-20 — AN-C-170 (See MIL-C-5541)
U.S.A. 72-53 (See AN-F-20)

BRUSH "ALODINE" PROTECTS ALUMINUM IN THE FIELD, SHOP, OR HANGAR

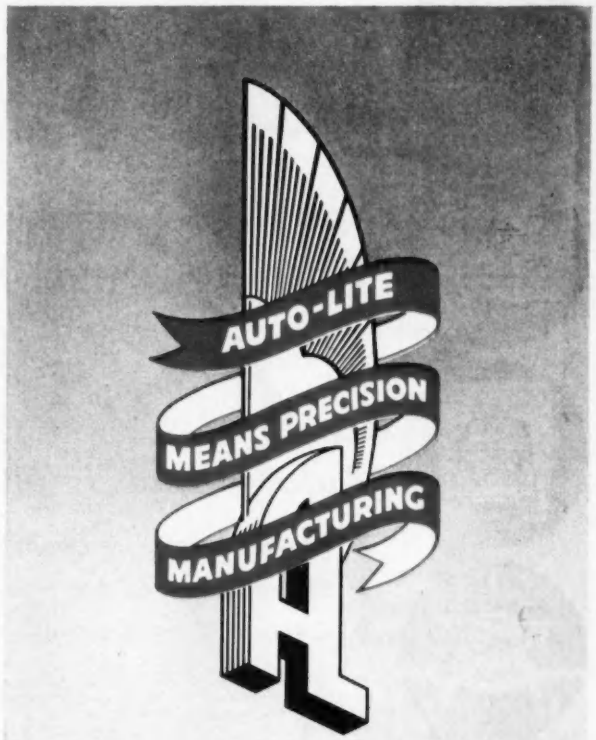
Brush "Alodine" is easily applied in a simple brush-on or flow coat process to large assemblies and surfaces—airplanes, trucks, trailers, boats, housing, building siding, railway cars, bridges, etc.—that are too bulky or too remote to be conveniently treated in tanks or a multi-stage power spray washer. The cleaning and coating chemicals for Brush Alodizing are shipped in bulk or in the convenient Brush "Alodine" Chemical Kit No. 1. This Kit contains enough chemicals to treat about 1,000 square feet of surface and is an ideal package for use at airfields of commercial airlines or of the Armed Services anywhere.

CHEMICALS ACP PROCESSES

WRITE FOR FURTHER INFORMATION ON "ALODINE" AND ON YOUR OWN ALUMINUM PROTECTION PROBLEMS.

CHEMICALS ACP PROCESSES

You're always right with



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AUTO-LITE works to serve the nation's needs in peace and in defense. In 28 great Auto-Lite plants from coast to coast, Auto-Lite produces more than 400 products which are original equipment on many makes of America's finest cars, trucks, tractors, airplanes and boats. Their 40-year record of dependable performance is summed up in the phrase, "You're Always Right With Auto-Lite."

THE ELECTRIC AUTO-LITE COMPANY
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Spark Plugs · Fuel Pumps · Batteries · Bumpers · Generators · Speedometers
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Starting Motors · Ignition Units · Instruments & Gauges · Windshield Wipers
Lighting Units · Wire & Cable · Gray Iron Castings
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You Keep Equipment Moving When You Install Permanent

KLIXON

Automotive Circuit Breakers

- **Provide Permanent Circuit Protection**
- **Eliminate Expendable Fuses**
- **Compact, Easy to Install**

Permanent Klixon Circuit Breakers safeguard wiring and electrical equipment for the full life of the vehicle. These compact, foolproof, easy to install Breakers overcome the disadvantages of expendable fuses — they do not destroy themselves when overloaded — they eliminate the need for carrying spare parts — no need to hunt for fuse blocks in inaccessible locations.

When properly applied, permanent Klixon Circuit Breakers prevent overcapacity fusing or "jumping" of the protective device which frequently happens when a fuse burns out and no replacement is available.

Install dependable Klixon Circuit Breakers in all circuits. Write for information today.

KLIXON

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Division of Metals & Controls Corp.

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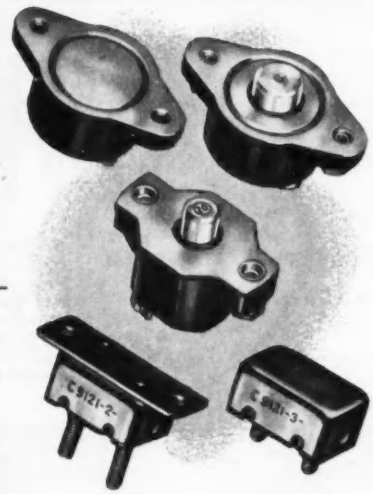

Typical Klixon Circuit Breakers

Klixon Circuit Breakers are available in a wide range of types and ratings to meet all circuit protection requirements.

NEVOLYA is an important word to Communist leaders.

It means SLAVERY.

It keeps the Red Masters in power.

NEVOLYA is never mentioned by the pink-peddlers who preach Communism.

Resist any schemes which might shackle you.

They lead to Communism and the price is NEVOLYA.

BOHN

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GENERAL OFFICES: LAFAYETTE BLDG. • DETROIT 26, MICHIGAN

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FACTS FOR INDUSTRY

FOR RELEASE: September 24, 1951

SERIES: M31L-00

INTERNAL COMBUSTION ENGINES
(EXCEPT AUTOMOTIVE AND AIRCRAFT)
1950

WISCONSIN *Air-Cooled* ENGINES Again Take *First Place!*

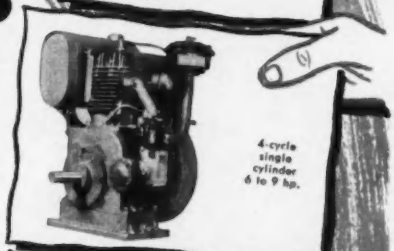
The latest U.S. Bureau of the Census statistics again provide proof of *top preference* for Wisconsin Heavy-Duty Air-Cooled Engines.

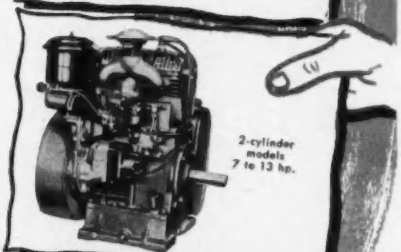
According to Census Bureau figures covering ALL carburetor type internal combustion engines (except automotive and aircraft) made by 41 different manufacturers, a total of 566,777 engines of 11 to 175 cu. inches displacement were produced and shipped by these concerns to other companies during 1950. (This does not include so-called "captive" engines built and incorporated into equipment of the same company).

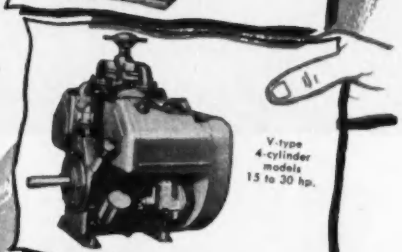
Of the total of 566,777, Wisconsin Motor Corporation figures show that 206,737 were produced by this company, or 36.4% of the total in the specified H.P. range. The balance of 63.6% was divided among 40 other engine builders.

These figures are significant because they again offer outstanding *proof of preference* for Wisconsin Air-Cooled Engines by power equipment builders, distributors, dealers and users of power-operated machines and engines. And this preference is based on PERFORMANCE — best expressed by "Most H.P. Hours" of on-the-job service.

It pays to build, sell and use GOOD ENGINES. You can't do better than to get behind Wisconsin Heavy-Duty Air-Cooled Engines . . . *the line of least sales resistance and top preference.*







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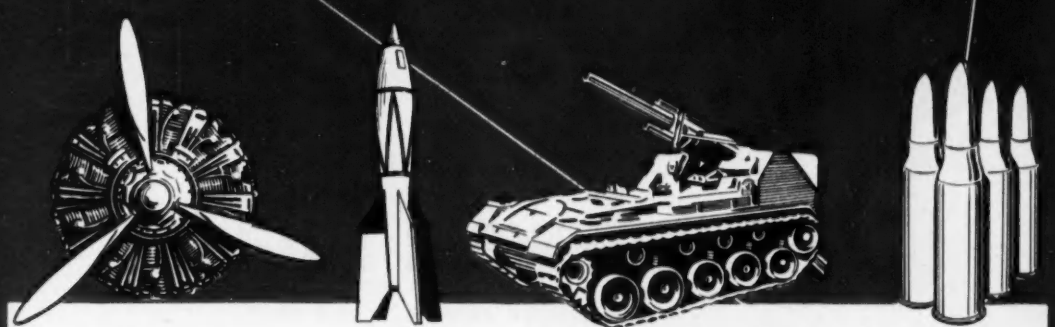

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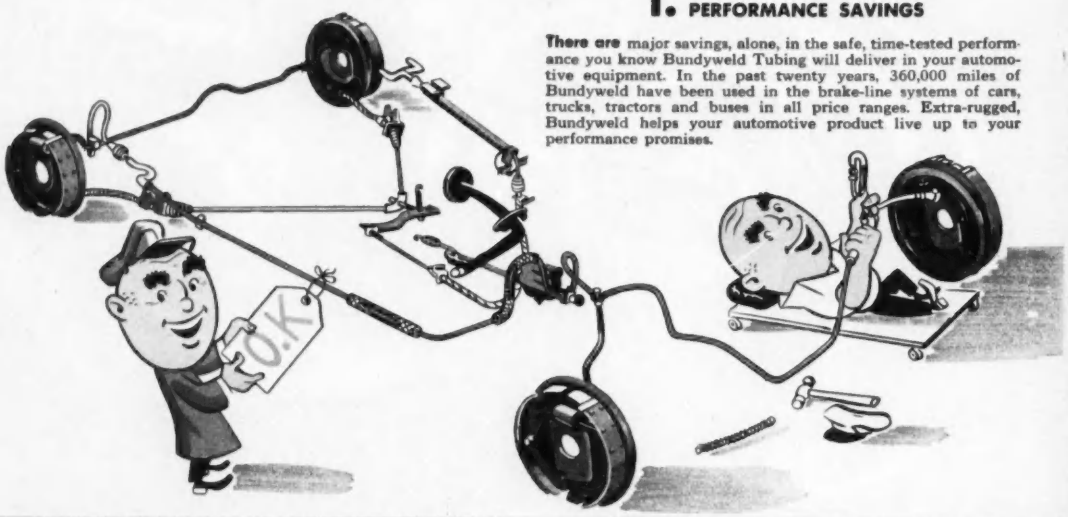

2. FABRICATION SAVINGS

Once your designers work out new tubing parts, trust Bundy to come up with the fastest, most practical way to produce them. You save, because Bundy can run with the ball, turn out parts that help achieve your engineering, design or performance objectives. Typical of Bundy-created parts is the hydraulic line, above, for automatic car-window lifts.

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continuously rolled twice around laterally into a tube of uniform thickness, and

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Bundyweld, double-walled and brazed through 360° of wall contact.

← **NOTE** the exclusive patented Bundyweld beveled edges, which afford a smoother joint, absence of bead and less chance for any leakage.

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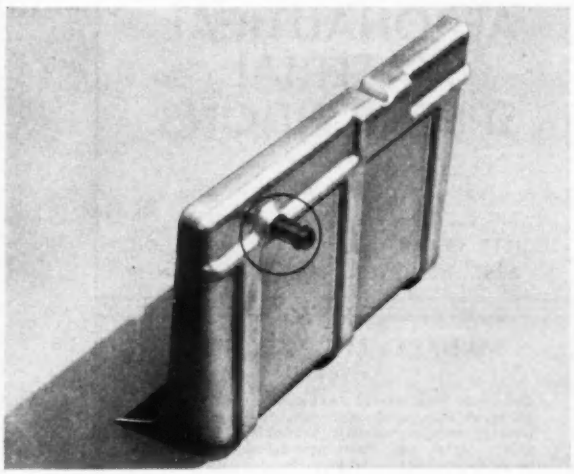
You buy the industry's finest engineering skills, which can mean major savings in the long run. Bundy men called in during critical design and planning phase are often able to bring about major savings in materials, tooling costs, or production time at that point.

Then, promptly, and *as specified*, Bundyweld rolls into your production lines—either fabricated by Bundy or in lightweight coils and lengths for easy, economical fabrication by your men.

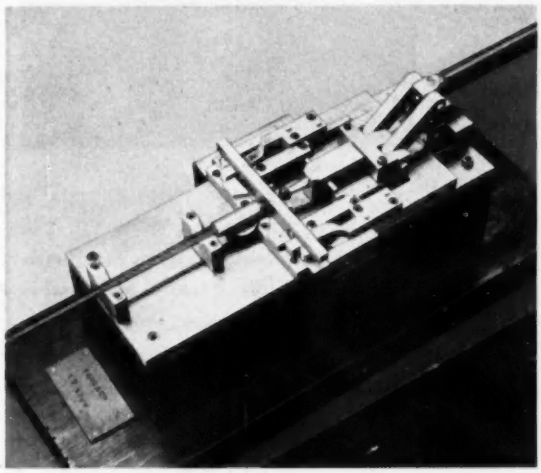
Price-minded, performance-minded automotive engineers know there is no adequate substitute for Bundyweld Tubing. *Or* for Bundy skills.

Contact a Bundyweld Distributor (listed lower left), or write direct to *Bundy Tubing Company, Detroit 14, Michigan*



3. COSTS CUT

You save through constant efforts inside Bundy to ferret out better, faster, more economical production methods. Example: Special burring operation on drain tube (circled) in battery tray, above, has now been eliminated by an improved production technique, and savings passed on to Bundy customer in lowered costs per unit. For *true* economy in automotive tubing parts, specify Bundyweld!



4. MORE PRODUCTION SAVINGS

Bundy-built assembler, above, demonstrates more typical Bundy production advances. Assembler automatically slips rubber washer over bead at end of tube, eliminates former expensive hand operation, speeds output at appreciably lower cost, which Bundy customer shares. Look into the ultimate cost of tubing; count by count, you'll find Bundyweld is your finest tubing "buy."

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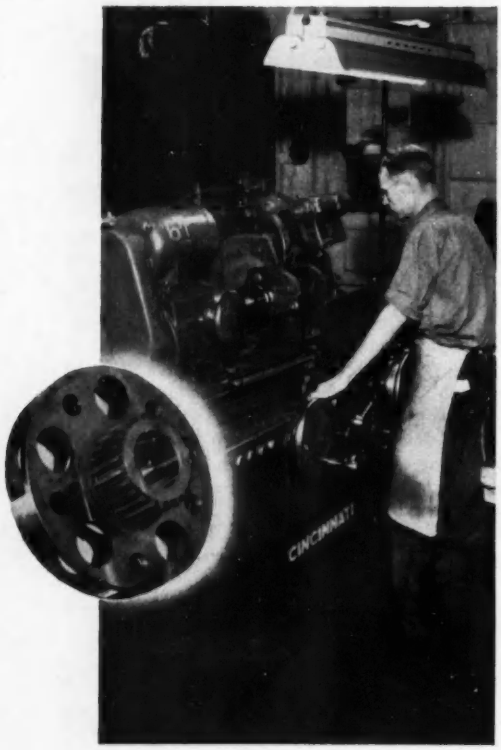

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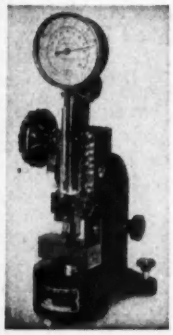

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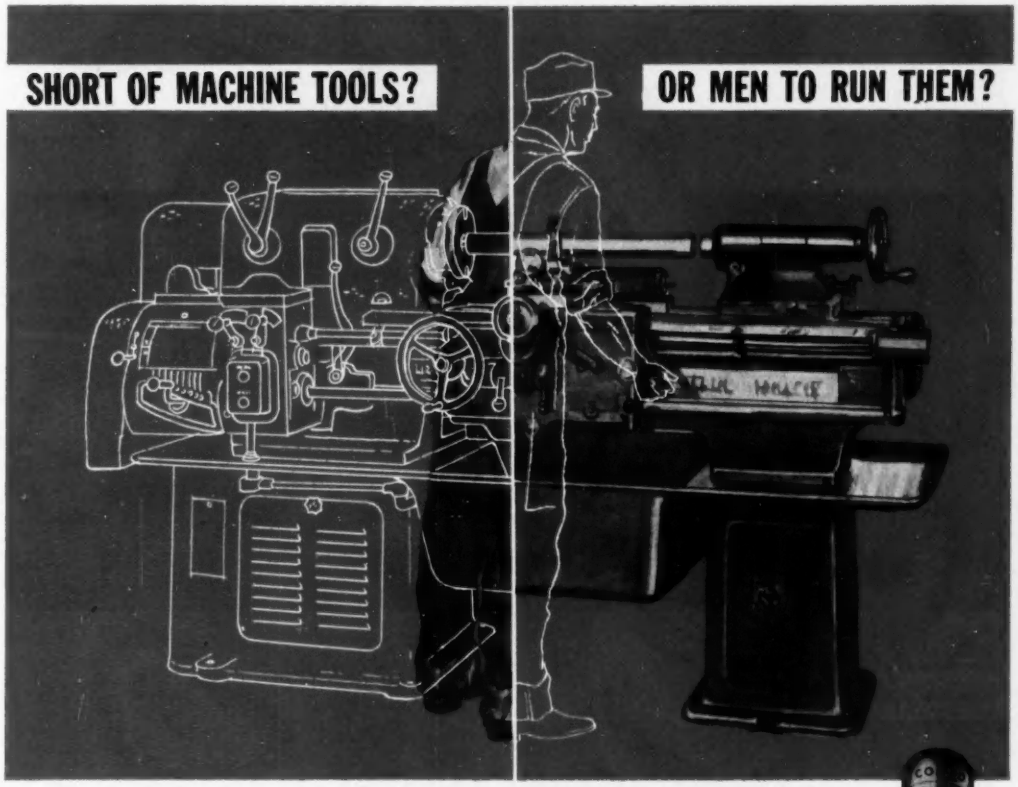

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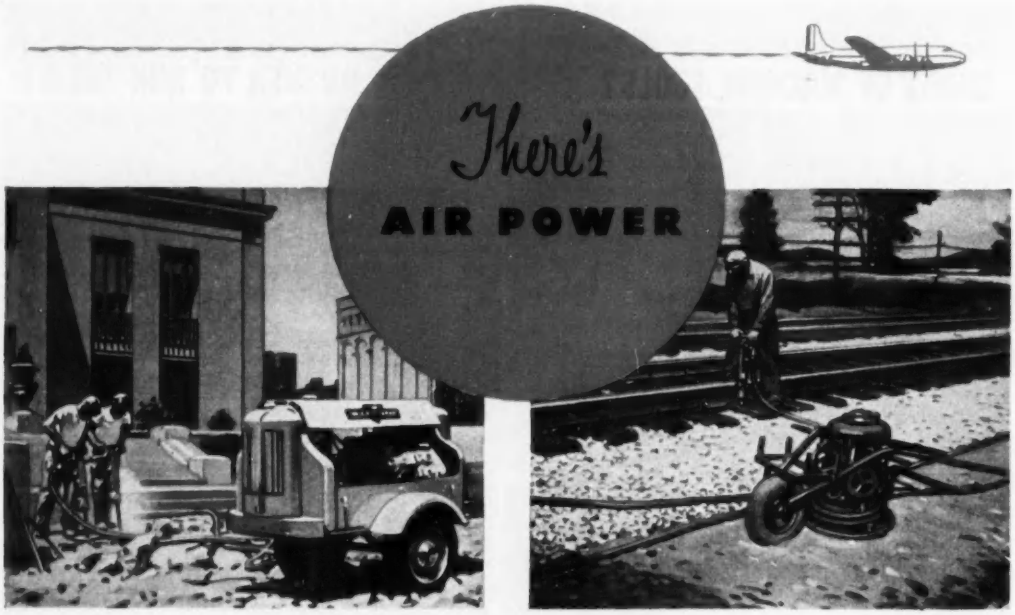

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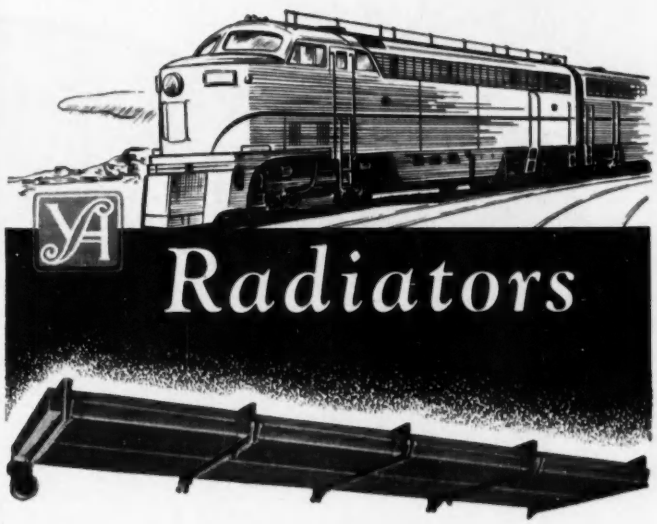

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in more ways than one with

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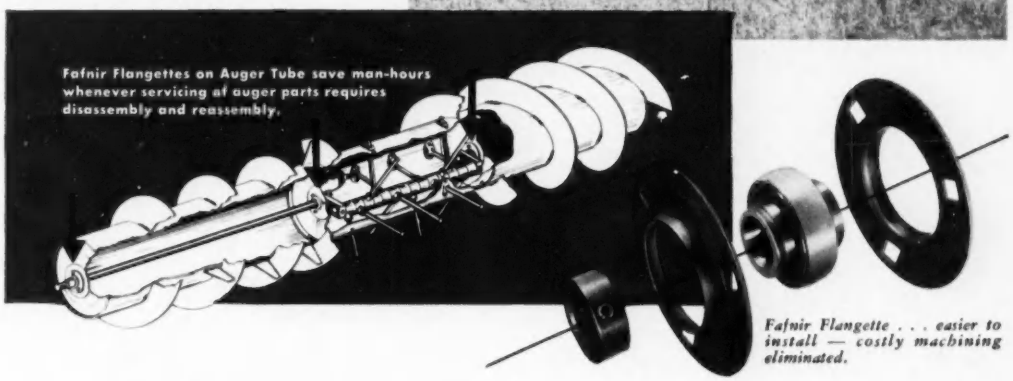
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Fafnir Flangette . . . easier to install — costly machining eliminated.

One man can do a lot of harvesting with the 14 foot Gleaner-Baldwin self-propelled, 70 H.P. Combine illustrated. It has the capacity to handle practically any crop. But more than that, it's designed to require a minimum of servicing time. For example, every constant rotating shaft (except slow speed reel) is mounted on anti-friction bearings . . . and that's where Fafnir Ball Bearings come in.

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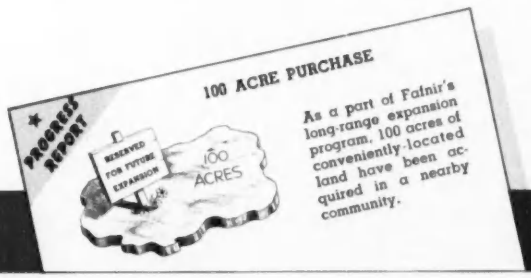
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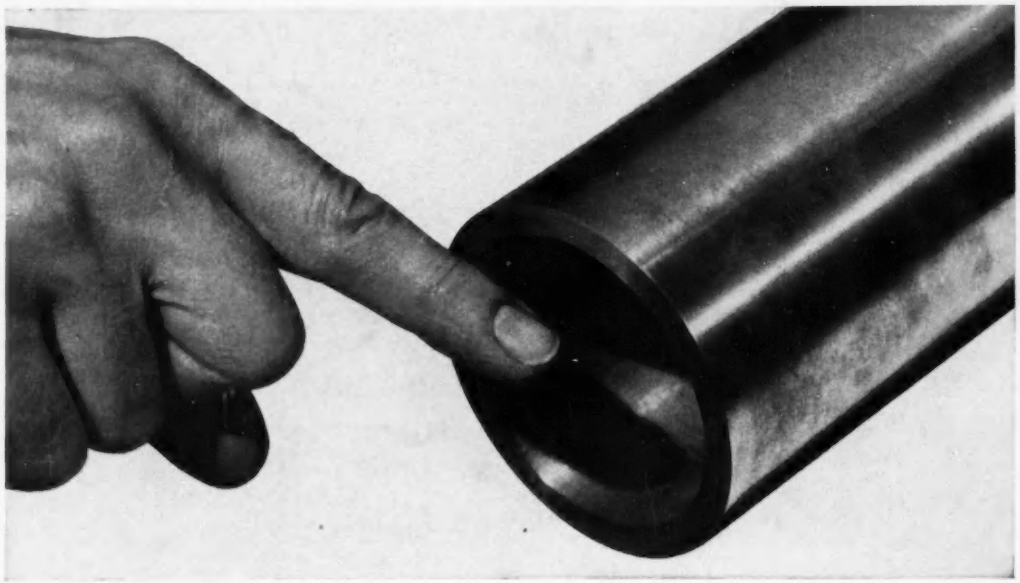

If you want to save steel on hollow parts, YOUR ACE IS IN THIS HOLE!

WHEN you use seamless tubing for hollow cylindrical parts, the hole is already there. You machine away less scrap than you do with bar stock, get more parts per ton of steel. And to help you save *more* steel, the Timken Company offers a tube engineering service which recommends the most economical tube size for your job—guaranteed to clean up.

With Timken® seamless tubing, you make your machine tools more productive. Drilling the center hole is eliminated; finish boring is often your first production step. As a result, screw machine stations are released for other operations. You have more machining capacity without adding more machines.

Because the piercing process by which Timken tubing is made is basically a forging operation, you have fine forged quality in your product. The tubing has a uniform spiral grain flow for greater strength and a refined grain structure which brings out the best in the quality of the metal. And from tube to tube and heat to heat, this quality is always uniform due to the Timken Company's rigid quality control. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

Specialists in alloy steel—including hot rolled and cold finished alloy steel bars—a complete range of stainless, graphitic and standard analyses—and alloy and stainless seamless steel tubing.